TECHNOLOGY DEPT.

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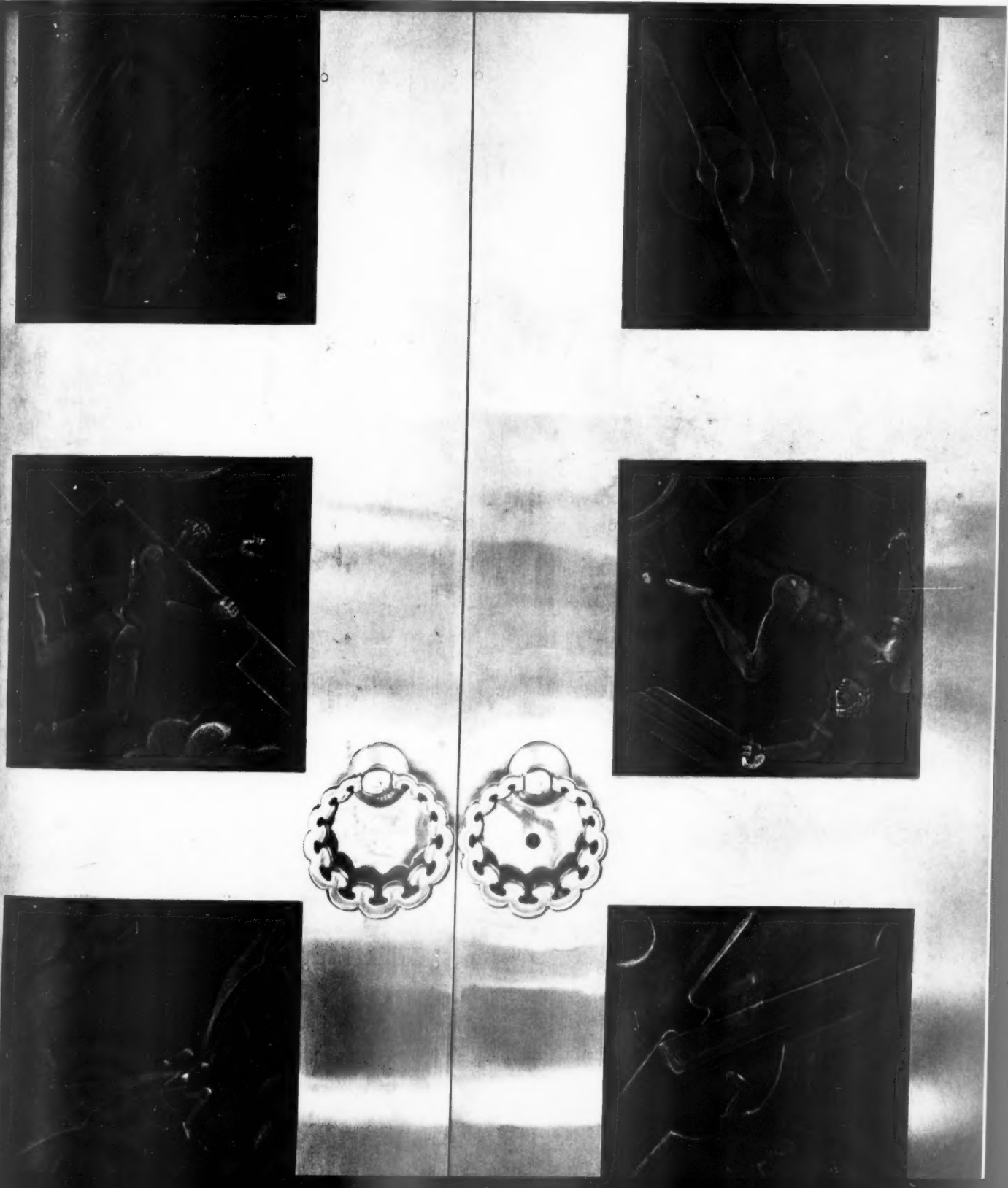

MY NEW YEAR RESOLUTION

Chesterfields

FOR MORE PLEASURE

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THE TECHNOLOGY REVIEW, January, 1939. Vol. XLI, No. 3. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

THE TABULAR VIEW

TO detect and encourage sound books on science written for the layman or, rather, for the intelligent reader who wishes to be informed about "the greatest triumph of the human mind" is a proper function of this magazine, and we are exercising it to a greater extent than ever before. You will note, for example, the thoroughgoing review by NORBERT WIENER in this issue's Trend of Affairs section and you may recall the extensive review last month of Hogben's "Science for the Citizen." The Review feels that it has one of the best opportunities of any magazine to provide readers with sound appraisal of popular science literature, and it expects to do so.

A GRADUATE of the United States Naval Academy in 1910, Commander HENRY E. ROSSELL, C. C. U.S.N. Retired, received his S.M. from the Institute in 1915, joined its staff in 1931, and became the head of its Course in Naval Construction, succeeding Professor Hovgaard, in 1933. The Review presents Commander Rossell's article on page 120 in response to requests from readers for a discussion of the importance of aircraft in warfare, and there is probability that other experts will discuss air offense and defense in later issues of The Review. Commander Rossell's article is presented only as the private ideas of the author. ¶ Anyone who carries in the back of his mind the amusing story of the American engineer, temporarily living in Mexico, who did not know there were termites in his home until the piano fell through the parlor floor will want to know more about these destroyers. CHARLES H. BLAKE, '25 (page 123), is an assistant professor of zoölogy, having joined the staff at M.I.T. in 1924. He is a fellow of the American Academy of Arts and Sciences, a trustee of the Boston Society of Natural History, and associate curator of mollusks for that society.

BECAUSE this issue is his last, the retiring Editor ventures to close it on a note more personal than normally is appropriate for these pages. He salutes The Review readers and contributors, for he knows well that they have given the magazine its chief strength and distinction during the 13 years — 115 issues — that he has known it. More specifically he bears tribute to these: to his chief, the Publisher, whose achievement it has been to make The Review a soundly organized and stable enterprise and a magazine with which one may be proud to be associated; to the Business Manager whose skill in breaking down the barriers between the counting room and the editorial desk has given The Review singleness of purpose along with abundant solvency; to the staff, named and unnamed on page 109 and experts all, who in every sense have been partners in our enterprises; and to all of the above together, for they have formed an organization of which it has been an experience in friendship to be one part. Finally he salutes the incoming Editor, for he has great contributions to make to The Review and abiding satisfactions to be obtained from it.

J. R. K.

No. 12

Just for Fun!

A CHALLENGE

TO YOUR INGENUITY

TWO well-insulated compartments, filled with a "perfect gas," are *maintained* at absolute temperatures T_1 and T_2 respectively. If a large tube connects the compartments, the pressures (P_1 and P_2) naturally tend to equalize, but [believe it or not] if the proportions of

the tube are suitably reduced, the dynamical theory of gases indicates that a steady state will be reached in which the relationship $P_1/P_2=[T_1/T_2]^{1/2}$ is approached. Can you verify and explain this formula?

Mr. O. Brune, 50 Galway Road, Parkview, Johannesburg, Union of South Africa, won our Puzzle No. 4 prize contest. See page 106.

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MAIL RETURNS

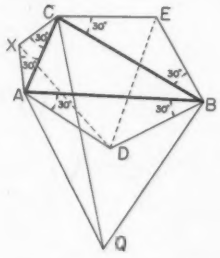
LETTERS FROM REVIEW READERS

Prize Puzzle, 4's, and Gears

FROM THEODORE M. EDISON, '23:

The prize offer for the best solution (with proof) of the puzzle (No. 4) which appeared in the Calibron Products, Inc., advertisement in your February, 1938, issue led to such a prodigious expenditure of effort that our conscience bothered us a little! However, your readers showed so much interest in problems for their own sake that the series was continued.

The $25 prize went to O. Brune, '28, for the following beautifully simple analysis:



The problem: Starting with *any* triangle *ABC*, construct three exterior triangles having base angles of 30° and vertices at *D*, *E*, and *X* — as indicated in the diagram. If the distance *DE* is taken as 100, what is the distance *DX*?

Solution: $DX = DE = 100$.

Proof: On the side *AB* construct also the exterior equilateral triangle *ABQ* and draw the straight line *CQ*. Now the triangles *EBD* and *CBQ* are similar, for $BC/BE = [BA/BD] = BQ/BD$ $(=\sqrt{3})$ and $\angle EBD = \angle CBQ$ $(= \angle B + 60°)$. Therefore, $QC/DE = BQ/BD$ $(=\sqrt{3})$. In the same way the triangles *XAD* and *CAQ* are similar, and $QC/DX = AQ/AD = BQ/BD = [QC/DE$, as already shown$]$ $(=\sqrt{3})$. Therefore, $DX = DE$.

Q. E. D.

Most of the 67 solutions, sent in by 62 individuals, were long — one running to six pages of neatly listed formulas. Seven additional replies were ruled out because they were inadequate: They dealt with special cases or based their "proofs" on a statement of ours that the answer was a definite number.

We do not recall how we first learned of the relationship upon which our puzzle is based (we did not find it ourselves), but we here extend our congratulations to the discoverer of the fact that *DEX* is an equilateral triangle. A very good proof, received from L. B. Tuckerman, '06, of the United States Bureau of Standards, shows that the external isosceles triangles may be replaced with equivalent internal triangles to obtain a similar result.

* * *

Turning now to the two other problems which stirred up most discussion, here is the answer to Puzzle No. 2 (December, 1937, Review). The numbers 32, 36, and 64 can be expressed with two 4's and symbols as follows:

$$32 = \sqrt[4]{4^4}, \ [= 4^{\frac{4}{4}}]; \quad 36 = \frac{4!}{\sqrt{.4}}, \left[= \frac{4 \times 3 \times 2 \times 1}{\sqrt{.4444\cdots}} = \frac{24}{\sqrt{4/9}} \right]; \quad 64 = \sqrt{\sqrt{\sqrt{4^{4!}}}}.$$

In Puzzle No. 10 (November Review), our specifications would be all right for simple rollers, but with gears, the dimensions must be changed to keep the teeth from jamming. The gears will run properly on their pitch lines when the diagonal dimensions have certain definite values only. One of these is about .007″ less than the 4″ dimension specified. Starting with an arrangement in which the four gears are in perfect mesh on their pitch lines, one diagonal dimension can be increased slightly, provided that the other diagonal dimension is *also increased!* Thus, in our problem, the 4″ dimension can be retained if the 3″ distances between gear centers are increased a little — still using 3″ gears. In spite of the fact that the fit would then appear to be loose, the system will run with practically no lost motion.

West Orange, N. J.

Air Conditioning in England

FROM ARTHUR B. MARSH, '29:

I have noted with considerable interest the article on page 10 of The Review for November — the article on the L. M. S. centennial. It was of interest to me not only because of the opportunity I enjoyed this summer of seeing the displays of rolling stock and locomotives here in London's Euston Station but because the article referred to the more modern phases of air conditioning as applied to British railway carriages.

At the present time I am representing the Carrier Corporation of Syracuse, N. Y., as liaison officer to J. Stone and Company of London. Believing it might be of interest to you, perhaps I can elaborate somewhat on the article. The "air conditioning" referred to on L. N. E.'s *Coronation* and *Coronation Scot* is in reality not true air conditioning as we know it. These trains do possess "pressure ventilation," which is filtered air circulated by a fan to the car interior through a concealed air-distribution system. It incorporates no cooling, humidifying, or dehumidifying provisions. This system was installed by the company with whom I am associated here in London.

It is interesting to note that in this type of ventilation plus filtering of the air, the British roads were somewhat ahead of American roads, as this type of system was in use in England and some of the Dominions before true air conditioning was devised for railway cars.

The L. M. S. will actually be the first British road or, rather, the first in England proper, to inaugurate true air conditioning when the new royal train goes into operation sometime during the year. It will make provision for cooling the air in addition to proper filtering of the air in summer and will heat and filter the air in winter by means of its specially designed air conditioner. Elaborate separation of the air supplying the smoking lounge from that supplying the royal suites is made for purposes of refinement. The carriages, when completed, will in every way incorporate the finest the railway and its suppliers are able to offer Their Majesties.

The air-conditioning industry is naturally interested in developing the railway market to the utmost, and while a marked improvement in the "feel" of the air will definitely result even in moderate climates, it is easy to understand the British point of view when during a summer the maximum temperature on perhaps six occasions reaches 84 degrees F. accompanied by moderate humidities.

I believe, however, there will be a very gradual adoption on English roads of the benefits of air conditioning that we now take as an accepted fact.

London, England

ECONOMY — WITH A MORAL

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Molybdenum steels and irons make production dollars go further in many ways. Our booklet, "Molybdenum in Steel", containing a great deal of practical data will be sent free on request to technical students and others interested.

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MOLY

Chas Goodyear

THIS year marks the One Hundredth Anniversary of the discovery of the vulcanization of rubber. In recognition not alone of Charles Goodyear's contribution to the world, but also of the self-sacrifice, the faith and courage of the man, this tribute is published by an enterprise which, though founded long after his death, has striven under the inspiration of his example, and seeks by serviceability to deserve his name.

THE GOODYEAR TIRE & RUBBER COMPANY, AKRON, OHIO

HE walked the streets in downpouring rain in a strange garment of rubberized cloth.

He met the jeers of the world with a faith that neither disaster nor seeming disgrace could conquer.

He laid upon the altar of his work all the dear things of life — health, family, friends, fortune, happiness.

He was cast into prison for debt.

He felt himself "appointed of God."

He discovered the vulcanization of rubber.

His name was Charles Goodyear.

◆ ◆ ◆

"NOTWITHSTANDING all the difficulties he encountered, he went on. If there was reproach, he bore it. If poverty, he suffered under it. But he went on, and people then saw, when his invention was completed, that what they had been treating with ridicule, was sublime; that what they had made the subject of reproach, was the exercise of great inventive genius; that what they had laughed at, the perseverance of a man of talent with great perceptive faculties, with indomitable perseverance and intellect, had brought out as much to their astonishment, as if another sun had risen in the hemisphere above . . .

"I believe that the man who sits at this table, Charles Goodyear, is to go down to posterity in the history of the arts in 'this country, in that great class of inventors, at the head of which stands Robert Fulton . . . in which class stand the names of Whitney, and of Morris, and in which class will stand 'non post longo intervallo' the humble name of Charles Goodyear."

From the address of DANIEL WEBSTER *before the U. S. Circuit Court, District of New Jersey, in 1852.*

F. S. Lincoln, '22

On the cover of this issue are reproduced the handsome doors of the Wright Memorial, Kill Devil Hill, N. C. Here the doors stand open (left). The nearer picture shows the memorial silhouetted against a cloud-flecked sky

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From a photograph by F. S. Lincoln, '22

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THREE WEEKS MUST BE ALLOWED TO EFFECT CHANGES OF ADDRESS. BOTH OLD AND NEW ADDRESSES SHOULD BE GIVEN.

© F. S. Lincoln, '22

NEWS

Model of a plaque by Isamu Noguchi for the Associated Press Building, New York City

THE
TECHNOLOGY REVIEW

Vol. 41, No. 3 January, 1939

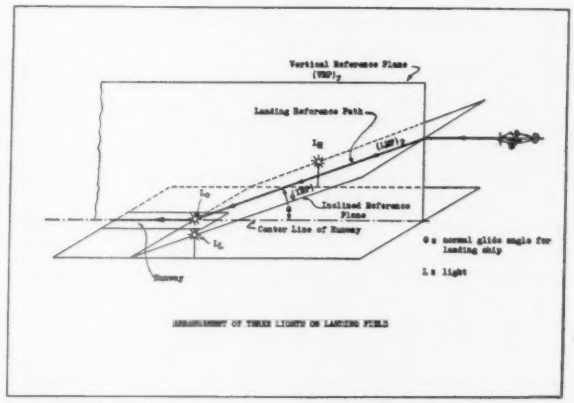
The Trend of Affairs

Trails in Space

THE power of coöperative investigation which is realistic enough to exhaust the possibilities of available existing materials before undertaking to construct new ones has been well illustrated at the Institute during the past year. The development of a blind-landing device for airplanes which bids fair to overcome one of the greatest hazards of aviation is the illustration. Previous systems utilizing "beam flying" have been only partially successful; a scheme which will give a fog-blinded pilot information about the position of his ship with respect to both its own horizontality and its relation to the landing field can be expected to come nearer complete satisfaction. And if the information can be got to the pilot in a form readily interpretable in geometric terms, so much the better.

If on a clear night an airplane nears a landing field, the pilot can be guided to a safe landing by means of three sources of light — one centered at ground level near the end of the field where the ship is to make contact, the others elevated aboveground opposite each other at each side of the field and some distance in front of the first light. The three thus sighted from above define a plane; if the pilot comes in on an imaginary line bisecting the plane, all will be well. This imaginary line is in fact a landing reference path. So reasoned Irving Metcalf of the Bureau of Air Commerce. Flying tests demonstrated the truth of his reasoning. Then developed the problem of getting the aid from such a light system reproduced in an airplane coming to land not on a clear night but in the midst of fog. An indirect application of the basic idea was needed.

For this, the Bureau of Air Commerce had recourse to M.I.T. The problem posed to a group headed by Professor Edward L. Bowles, '22, of the Department of Electrical Engineering was essentially this: to produce in a fog-blinded plane in flight the illusion of the three lights, and to produce this illusion in such a way as to make clear the attitude of the plane and the direction of approach toward the field. Professor William M. Hall, '28, suggested that the gyroscopic equipment of the plane itself could be put to work in the solution, for this already gives information as to bank and climb, the aerial equivalents of the roll and pitch of a ship at sea. By the use of electrical circuits hooked to the gyro elements, involving the use of very delicate brushes only about three-thousandths of an inch in thickness, the gyroscopes were made to produce three spots of light on the screen of a cathode-ray oscillograph, thus creating the illusion in the plane of the unseen three lights on the field. Professor Charles S. Draper, '26, of the Course in Aeronautical Engineering brought his expertness with aerial instruments to bear on this phase of the problem.



Pictorial diagram, supplementing the adjacent story, showing the principle of the new blind-landing system. Here we see the straight line reference path down which a landing airplane may fly at its natural glide angle

Patch

SAUSAGE

Patch

BANYAN

TREES

. . . are made by God alone, the poet has told and told and told us. Their names, however, are the product of man's vernacular fancy, as some of these photographs from Hawaii by Claude E. Patch, '02, and Carl B. Andrews, '28, disclose. The sausage tree advertises its cognomen in its pods; the rattle of dry fruits in the wind is basis for the characteristic masculinism of the title of the "women's tongues"; that not all bark will bark the knuckles appears at your left, where the disembodied fist smites, unhurt, the soft integument of the red gum eucalyptus

End result was a system whereby bank and climb — the attitude of the plane — were indicated by changes in the positions of these three spots.

With the pilot thus enabled to keep his ship steady with a minimum of difficulty, the next question was that of bringing him to the field on a true line, literally that of blazing him a trail in space. Here two possibilities were to be canvassed — the infrared rays and radio waves. Infrared's fog-piercing possibilities, already much investigated, were examined thoroughly. Radio waves offered more assistance. In the system devised, two beams of these directed angularly upward from the field, one under the other but overlapping somewhat, are modulated at different frequencies. Antenna and conversion devices in the plane serve to keep the center spot of light on the instrument in position as long as the ship is on the path defined by the overlapping beams. Deviation into the region above or below shifts the center light accordingly. Thus the position of the airplane above or below the reference path and the angle of its approach to the earth are cared for. A similar arrangement was provided to govern deviation to the right or left through changes in the relative position of the right and left lights. In this aspect of the problem, the fact that the beams had to be sent up at an angle from the earth was of importance, for it meant that the effect of the earth upon them might cause the path to vary undesirably in slope and linearity. Hence it was essential that true controlled beams be available. Dr. Wilmer L. Barrow's ('29) method of projecting extremely short radio waves in narrow flat beams from horns here found immediate and practical application, which has provided material for graduate instruction.

During the first year of investigation of the problem, these were the developments. The instruments and indicators necessary have been completed in experimental form. The first year's work was positive in all its results, both those dealing with blind landing and those dealing with the use of the same instruments in route flying. Under a new agreement with the recently established Civil Aeronautics Authority, the radio phase of the question will almost entirely engross the researchers for the next 15 months. The practical consequences of the development are distinctly great, as is indicated by the coöperation of the aviation industry, the Army, and other associated groups.

It Floats

WHEN we heard the other day of a way by which printing ink might be removed from repulped paper, we picked up a trail leading to a versatile industrial process that's gaining importance steadily. A curiosity in 1903, a trend in 1912, a method that is handling 300,000,000 tons of ore a year at present, and tomorrow perhaps an established tool for the chemical engineer, flotation — for that's the name of the process — deserves more publicity than it has received.

As with any successful process, it has spread (amid continuous patent squabbles) because it has brought otherwise unobtainable profits, but its specific advantages are that in the mining industry it can generally handle leaner ores than can other methods — in fact, it has recovered minerals profitably from the dumps left by older, less effective processes; it can handle, must handle, finely crushed ores that give trouble in other concentrating methods; and it can do these things with a more compact plant and a simpler flow sheet.

These very small particles are the substance of flotation. As Charles E. Locke, '96, puts it, most of the low-grade ores mined today require very fine grinding before each ore particle is freed from all material not like itself, and "flotation becomes automatically the only means of high recovery." The thoroughness required in this operation is attested to by its up to 50 per cent share of the operating costs, the flotation step itself taking perhaps another 25 per cent.

Patch

WOMEN'S TONGUES

Patch

MONKEY POD

In its simplest form the flotation process consists first of finding some surface-active substance which will wet or film one type of particle in the ore but not other types. Quoting Professor Locke again: "If air bubbles are introduced into a properly prepared pulp or suspension of finely pulverized ore in water, particles of certain minerals (those filmed by the surface-acting substance) will adhere to the bubbles, whereas particles of other minerals will not show this tendency and will remain separately suspended in the water. The air bubbles in rising out of the pulp carry with them particles of one mineral or group of minerals, forming a mineralized layer of froth which may be removed as a concentrate."

Specific gravity is not a factor in this method, except in limiting the size of the largest particle which may be lifted by an air bubble. This value varies from 200 microns for gold to about 2,500 microns for some of the lightweight minerals like coal. (A micron is one-thousandth of a millimeter.) The optimum particle size is considerably smaller than the figures given, for the bubbles average about two millimeters in diameter, and the mineral particles must stick to the bubble's skin to form a ragged coat of mail.

The effects of this process have been felt in unexpected ways. Pine oil was quite early found an effective frothing agent — that is, a material capable of strengthening the bubble film so that it will not collapse prematurely. Fortunately heavy demand arose among the metallurgists just about the time when the naval stores industry was beginning the large-scale utilization of deadwood and stumps as sources of resin and turpentine. Among the by-products was pine oil, a substance extracted from the dead trees but not from the living ones.

In the mining of copper sulphide ores — at present the most important domain of the flotation process — the trend before its introduction was strongly toward larger and larger blast furnaces. The flotation process has brought radical changes by yielding a fine product exactly suited to the more economical reverberatory smelting furnace, using cheap pulverized coal. Blast furnaces which used the more expensive fuel, coke, and handled only coarse ore because fine material was blown out by the blast unless previously sintered, have largely passed out in the wake of flotation's steady progress.

Andrews

TREE FERNS

If the future sees the spread of the flotation process to iron-ore mining — and it probably will — the same effects may follow with repercussions on the economies of the steelmaking regions. Overshadowing the changes in plant, there may be the lowering of costs which must be paid by nations striving for self-sufficiency in steel with inadequate domestic reserves of high-grade ore but with plenty of low-grade material. If present plans to beneficiate the low-grade iron ores of Germany (containing an average of 34 per cent iron instead of the more than 50 per cent material generally mined) are realized, that country could easily double her domestic production of pig iron, at present only 20 per cent of her requirements. And even without that increase — with all its implications concerning foreign exchange — Germany may be the world's largest producer of steel in 1939. In this country, the Bureau of Mines reports that from the Mesabi district waste containing 17 per cent iron has been converted into concentrate containing 57 per cent iron at an estimated cost of $1.30 per ton.

At the moment, however, attention is focused on the rapid spread of the flotation process to nonmetallic and even strictly chemical materials, many of them worth only from $2.00 to $15 a ton. According to the Bureau of Mines Report of Investigation 3397, outstanding achievements in this direction have been the beneficiation of phosphate deposits, cement rock,

limestone, manganese ores, fluorite, and the potash salts of Carlsbad, N. M. In the Florida fields alone, sufficient capacity now exists to handle 10,800 long tons of phosphate daily.

In coal mining, where the application is two decades old, a political factor now intrudes, for froth flotation can produce a coal very low in ash content, and such a product, besides being useful in the chemical industry, is the most desired feed for hydrogenation plants. The Bureau of Mines report mentions an "intriguing project in coal treatment" for the recovery of fossil resins: "Preferably flotation might act as a roughing process. . . . In Utah, New Mexico, and Washington some of the bituminous and subbituminous coal beds carry high amounts of 'fat' coal showing coarse grains of amber-colored resin. . . . If 15 to 20 tons of coal must be extracted to give 1 ton of resin, the flotation and drying costs probably will make the resin cost $20.00 per ton above the cost of mining and transportation, which is normally carried by the coal anyway." Considering the prices that the natural resins bring in the market, the project is indeed intriguing.

Another unexpected application is in the separation of sodium chloride crystals from potassium chloride. The prospect of sidestepping much refining and recrystallization in the separating of crystalline materials has "already brought about considerable frenzied research." A German paper mill has successfully recovered over 90 per cent of the fiber in its waste water by flotation methods. A gentleman named Volokhvyanskii has found that simply by bubbling CO_2 through sugar juices, much of the ash, nitrogenous matter, and colloidal substances that generally form molasses are concentrated in the foam. Albumin has been removed from potato juice, sugar-beet juice, and urine by similar methods, as have dyes and other capillary-active substances from their solutions.

Before evidence of this method's new-found versatility becomes repetitious, it might be well to draw back and make a final survey. No huge flows of power feature this process; no aspect touches the imagination. Like the properties it deals with, it is cold, subtle, a little obscure. And like many of the men whose fortunes it has changed, it gains prestige not from itself but from the things with which it deals.

Charles Krutch, T.V.A.

Aiding Bones to Mend

NATURE may be helped in the business of mending broken bones and broken necks by new methods described lately before the Southern Medical Association by Dr. H. H. Hayes and Dr. Ralph M. Stuck. The new treatments offer improvement over older techniques in that each of them is designed to make life easier for the patient in the period during which the bone is setting. The plaster cast which

J. B. Tilcomb

broken legs have required, for example, prevents use of muscles while it is in place, so that sometimes as long a period is required for the unused muscles to regain their efficiency as was required for the bone to knit. Dr. Hayes circumvents this difficulty by the use of a bone fixator which permits use of the muscles and thus keeps them in working order. Driving metal pins or screws into the bone above and below the break, he hooks them to a yoke and attaches them to a metal bridge across the gap between the broken parts of the bone. The ends of the bone are brought into alignment for healing by means of four universal-joint braces which can be adjusted to any position. Metal pins are driven through the bone across the point of fracture. A local anesthetic suffices for this operation which has permitted some patients with broken legs to get out of bed and walk about on crutches, or even to return to work, within a few days.

A somewhat similar scheme for assisting the healing of broken necks was described by Dr. Stuck. Here, the effort is to pull apart the broken fragments of the backbone, by holding the patient's head up, so that they may have time to heal. Two holes are bored in the skull just back of the normal hairline, and into them a retracting device, or clamp, is inserted. Wires attached to the clamp exert an upward pull of from five to 30 pounds from weights attached to their ends. The patient thus equipped may move about in bed and so is considerably more comfortable than under the former method of treatment. He is also set free from much of the discomfort of the plaster collar customarily used in such cases: When neck fractures are treated by the new method, the plaster collar need be used only late in the healing process.

Dr. Stuck reëmphasized that many lives could be saved and many serious injuries avoided if spectators at accidents were less eager to move the victims.

Charles Phelps Cushing

"*March of the Iron Men*"

BY NORBERT WIENER

IT is by no means an accident that this is a year in which more than one book has been written to popularize industrial and scientific history. In this epoch of violent change and violent threats we must at all costs read the portents in the heavens and interpret the records of the past. Industrial and scientific development are doing to us something which we do not fully understand, but the understanding of which is vital to our comfort, our prosperity, our happiness, and our continued existence. Thus it is not only natural but most devoutly to be wished that men should devote themselves to the interpretation of the history of science, the history of invention, and the social role these have played in past ages. It is equally natural, though not in all cases so fortunate, that those who choose to write on these subjects should bring to their authorship widely divergent and varied qualities of information, technical understanding, literary ability, and enlightenment.

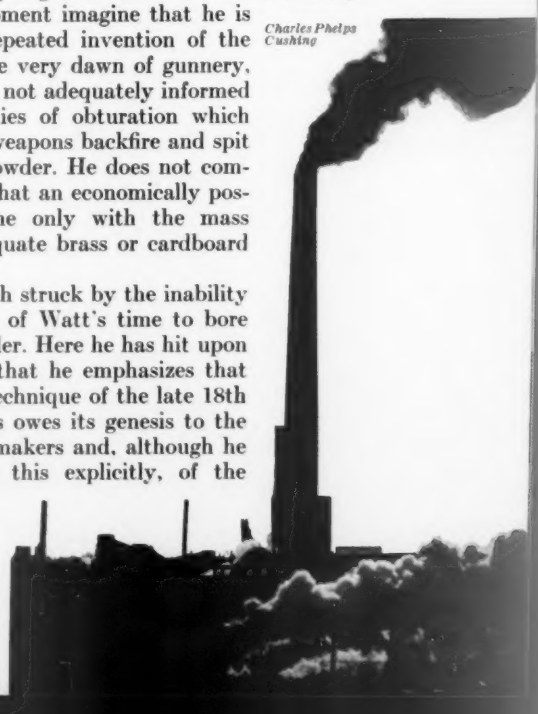
"March of the Iron Men" * is not, and does not claim to be, an impartial history of invention and science in all times. It is a book with a thesis — the thesis that the union of the United States of America has been dependent on unprecedented burgeoning of the inventive talent and that this burgeoning in turn has been rendered possible to an extent greater in America than in all other countries by the merits and the environmental background of American pioneer stock and American pioneer life.

Thus the book is an ex parte book, and indeed an ex parte book is what the background and training of the author, Roger Burlingame, lead us to expect. His career has been that of the journalist, novelist, editor, and professional literary man. This is a career well calculated to train a man in the use of libraries, in the accumulation of obscure and odd scraps of information, and in the presentation of this material in the form which will appeal best to the headline interest of the public. It is a career which will lead one to place great value on the striking, the epigrammatic, and the unusual. It is not of itself a career which will lead to a deep knowledge of science in its emotional life and its internal history, nor is it particularly conducive either to a view of the private psychology of the inventor or of the value and importance of stages in an invention which has not yet come to full commercial fruition. Neither does it of itself guarantee the economic, sociological insight which will make a connected, solid whole of such a piece of historical investigation.

Mr. Burlingame's book possesses to a remarkable degree the virtues and the defects which we should expect of an industrial history from an author with his background. The interpretation of the careers of Colt and of Whitney is new to most readers and must have entailed a large amount of competent and scholarly documentary research. Mr. Burlingame is obviously an enthusiast for the sailing ship, and although the subject of the Yankee clipper has been well and authoritatively treated by other hands, there is an interesting freshness in his chapter. As a journalist the author ranks high in competence and enthusiasm and in the skill of telling a story.

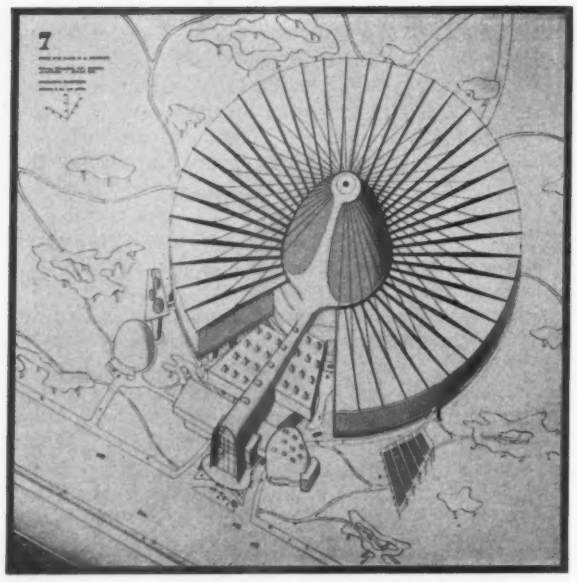
Behind these qualities of ready pen and practiced authorship — the virtues of a journalist — lie a journalist's shortcomings. The book is commonplace in conception, is narrowly nationalist in attitude, and is marked by no profundity of scientific or sociological vision. Where a number of legitimate claimants can be found for the same invention, Mr. Burlingame almost always picks the American without an adequate discussion of the merits of the case. Where an invention could have been made in a crude form in earlier times, although technical difficulties would have stood in the way of its effectiveness, Mr. Burlingame ridicules the primitive artisan. He is struck with the obviousness of the breechloader and wonders why such an idea was missed by the stupid gunsmiths of the 18th Century. I do not for a moment imagine that he is unaware of the repeated invention of the breechloader in the very dawn of gunnery, but he is probably not adequately informed as to the difficulties of obturation which made these early weapons backfire and spit and waste their powder. He does not comment on the fact that an economically possible solution came only with the mass production of adequate brass or cardboard cartridge cases.

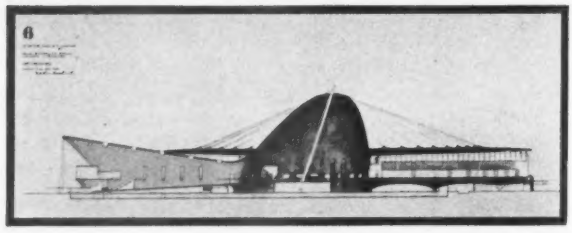
Charles Phelps Cushing



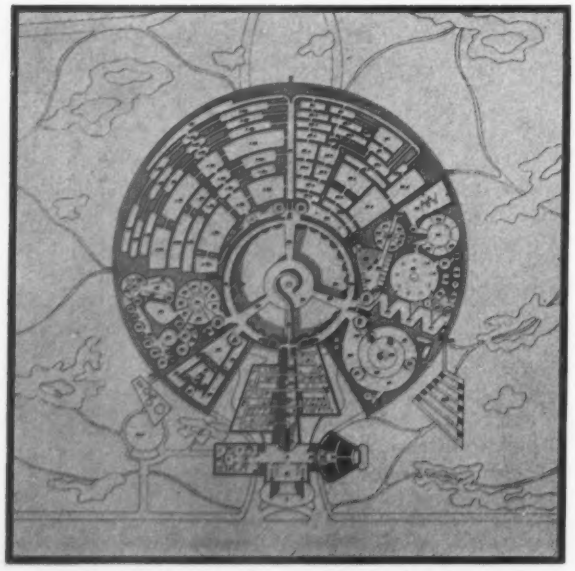
Again, he is much struck by the inability of the ironmasters of Watt's time to bore a true steam cylinder. Here he has hit upon the right clue, in that he emphasizes that the machine-tool technique of the late 18th and 19th Centuries owes its genesis to the craft of the watchmakers and, although he does not mention this explicitly, of the

* New York: Charles Scribner's Sons, 1938. 500 pages, $3.75.





Air view and section of proposed science museum show monolithic platform, funnel entrance, and parabolic dome (symmetrical in other section) from whose crown hang cables supporting radial roof beams, hinged where they abut the dome. This permits unusual plan flexibility for exhibiting the disciplines: A *mathematics,* B *astronomy,* C *physics,* D *chemistry,* E *biology,* F *medicine. See adjacent story*



instrument makers of the preceding generation. But he is not awake to the time and hard work of experiment necessary before these small-scale methods could be applied to the large-scale needs of heavy industry. In this connection he curiously misses a point vital to the history of invention in the Industrial Revolution: the tremendous effect on the clockmakers and instrument makers of the navigator's need for a method of determining longitude at sea.

Furthermore, in his discussion of the clipper ship we do not find a satisfactory treatment of one of the chief differences between American navigation and British navigation in the 19th Century — one which is most significant for modern industry. By this I mean the way in which American ships were racked to pieces in order to bring a maximum of profit in a few voyages, while English ships were less efficient money earners but had far longer lives. This new practice in the treatment of obsolescence is quite as vital to modern industrialism as the notion of interchangeable parts on which Mr. Burlingame lays such stress.

Besides the glorification of the American inventor as opposed to his foreign brother — which is indeed one of the theses of the book — there is a general Lothrop Stoddardism, a general tendency to exalt the old American stock at the expense of the inferior immigrant of the present day. Mr. Burlingame does not like foreigners unless they happen to be dictators. Of these indeed he speaks in measured tones of awe.

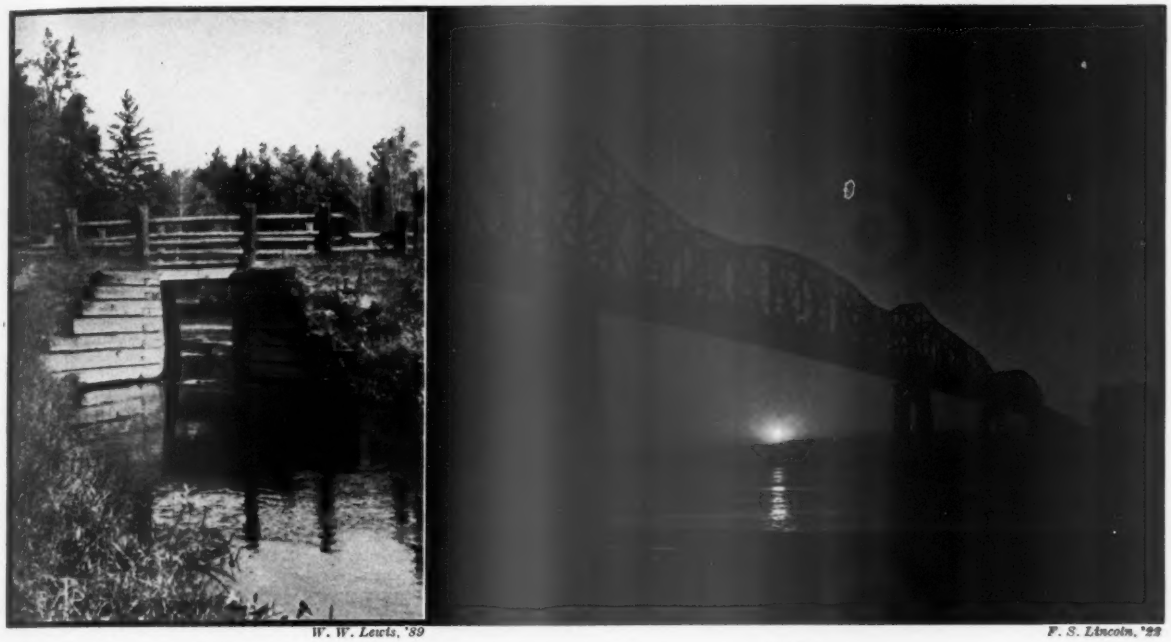
Mr. Burlingame and Mr. Hogben in his "Science for the Citizen" are exploiting mines in the same geological formation. Mr. Hogben, for all the possible merits and demerits of his highly individual methods, is exploiting his mine both as a scientist and a citizen. Mr. Burlingame has found in his own a profitable vein of copy.

Projet d'un Palais de la Découverte

MUSEUMS of science are attracting increasing attention in America as witnessed by the success of such institutions in New York, Chicago, Philadelphia, Cambridge, and Washington. In this country, as in Europe, they have made important contributions to public education, to the social assimilation of science, and to museography. They have profoundly affected the presentation techniques of all museums, even those devoted to art.

It is therefore not unexpected that planners of science museums should dare further innovations, even if only on paper. We refer to the extraordinary "Projet d'un Palais de la Découverte" exhibited last month at M.I.T. by Paul Nelson, native Chicagoan, wartime aviator, rebellious graduate of the Beaux Arts in Paris, where he has been a long-time resident and militant student of modern architecture.

The project arose from the success of the scientific show at the recent Paris Exposition. Nelson, assisted by two young Frenchmen, Nitzschké and Jourdain, was commissioned, with the help of French scientific circles, to make the studies for a permanent exhibition hall. Associated with him in the study were several distinguished French scientists. The project was completed



W. W. Lewis, '89 F. S. Lincoln, '22

FIRST LAST

How the Father of Waters grows in some 2,500 miles of his course may be gauged from these bridges — on the left the first span across the Mississippi, in Itasca State Park, Minnesota; on the right the Huey Long Bridge near New Orleans

and ready for presentation to President le Brun and to Edouard Herriot after the vacations — but before the vacations were over came Munich.

First conviction of the program was that a museum of science (and the very word museum has an unfortunate connotation) must be so flexible and extensible both horizontally and vertically as to permit freedom of change in the interest of presenting a living exposition of science always in evolution. Second premise was that a museum of this sort should employ the most modern methods of construction and the most modern materials as an epitome of scientific progress. Third, and final, belief was that it is necessary to seduce the average visitor and to "render his psyche malleable" by some sensational approach to the special disciplines which would require a closer study than he might otherwise give.

Feeling that the visitor to the ordinary museum has his first impressions blunted by material preoccupations with rubbers, umbrellas, cameras, and tickets, the architect has contrived that these activities take place in a small, covered lobby whence one can see nothing of the displays to follow. Thence he enters a funnel-shaped great concourse which leads him to a huge vaulted arena of truly colossal scale where he will be subjected to dramatically powerful demonstrations of the vigor of science.

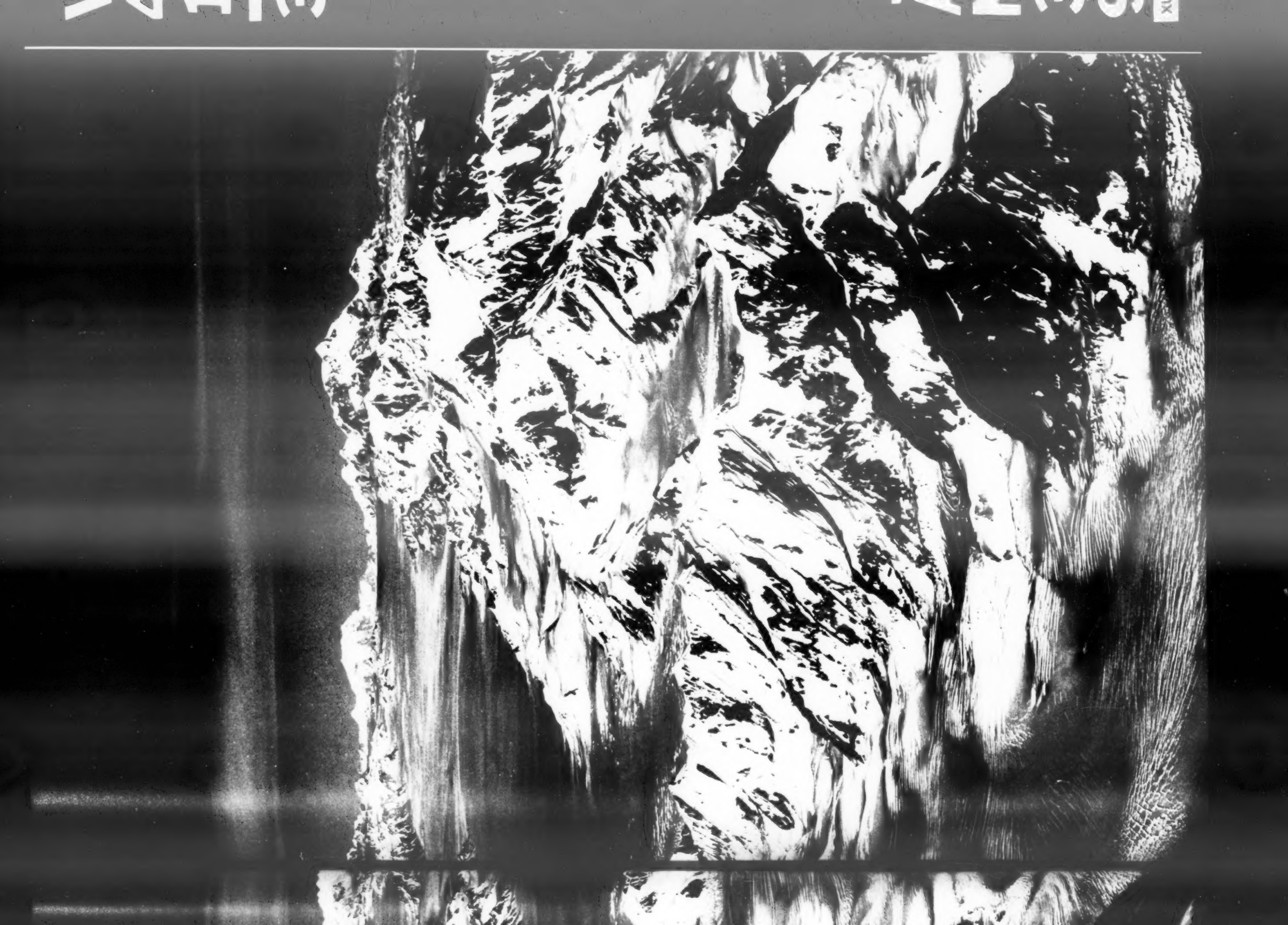
From such a center he is to be allowed to pass by one of the three ramps to the three segregations of the disciplines: (1) astronomy and mathematics; (2) physics and chemistry; (3) biology and medicine. In order to provide the flexibility desired, Nelson has contrived the interesting notion of building as rigid structure only the funnel, the great hall, and the huge circular platform which supports the exhibitions of the disciplines. Beneath this platform are to be the services. The platform is sheltered by a huge suspended roof supported from the vault by an interesting and entirely plausible structural method. From this roof, in turn, may be suspended the ceilings of the individual exhibition halls which may be entirely temporary. The whole building is, of course, inclosed in a sheltering envelope. The maximum modern facilities of lighting and air conditioning are assumed in the solution.

The arrangement of the disciplines was suggested by a specialist in each field. Physics and chemistry are closely related, and in the former, tangential axes care for mechanics, thermodynamics, classical optics, electromagnetism, radioactivity, radiation, statistical analysis, and wave mechanics, respectively; while radial axes carry the visitor through general introduction and measurements, discontinuous phenomena, continuous phenomena, and applications, respectively. To stress principles basic to all the sciences, it is possible to pass smoothly from a field in physics, for example, to the related field in chemistry. In medicine the visitor is introduced to the center of a spiral where he views the healthful man and then passes outward through a display of those things which weaken man and make him ill, and so to expositions of diagnosis, of therapeutics, and, finally, of preventive medicine. Not only was this project large in scale (700 feet

(*Concluded on page 146*)

On the Next Two Pages

. . . peaks and glaciers in Alaska and Canada, as infrared film records them in 1/100 second from an elevation of 15,000 feet. This oblique aerial photograph by Bradford Washburn shows mountains, from left to right, Lucania, 17,150 feet; Logan, 19,850, the highest land in Canada; Vancouver, 15,720; and St. Elias, 18,000, these last two in Alaska. In the foreground Martin River Glacier lies crumpled, with Bering Glacier at the upper right and Tanagla Glacier on the left



United States Navy

Naval Armaments

Do Aircraft Offer a Serious Challenge to Battleships?

By Henry E. Rossell

THE FUNCTIONS OF A FLEET — MAINTENANCE OF CONTROL OF THE SEA — CLAIMS FOR AIRPLANES — HISTORICAL ANALOGIES — NEGLECT OF OLD WEAPONS — MEANS OF ATTACK FROM THE AIR — MEANS OF DEFENSE — A HYPOTHETICAL WAR

THE opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

NAVAL strategists tell us that the primary function of a fleet in time of war is to maintain control of the sea and thereby to deny use of the sea to the enemy. Usually, however, the control is exercised over only a comparatively restricted zone which is of particular significance in a military sense.

For example, in the World War, Germany used naval power to control the Baltic and thereby to cut off Russia from sources of supply except through several unsatisfactory ports on the Arctic and Pacific oceans. Doubtless Russia's early collapse was caused largely by her partial isolation — the direct result of this exercise of German sea power.

Also in the World War, Great Britain controlled the North Sea, the English Channel, and the other waters surrounding the British Isles. This control was essential to Britain's existence as a belligerent, for without it her armies could not have been transported to France, nor could her civilian population have survived. Another important advantage enjoyed by Great Britain by virtue of her control of the sea lay in the shutting off of supplies to Germany. Thus British sea power advanced the cause of the Allied armies and impeded that of the enemy.

Many similar examples, such as Japanese naval strategy in the Russo-Japanese War, could be cited to illustrate the exercise of the primary fleet function of control of the sea or such restricted part of the sea as is involved in military objectives.

Of course there are many other fleet functions, all of which must be considered as of secondary importance. One of these duties in the late War, for example, was to mop up the few scattered ships of the German navy still at large after the outbreak of the war. So long as they were afloat, these vessels constituted a threat to Allied commerce. Naval operations in connection with secondary functions may often lead to spectacular feats or even to naval battles: Witness the remarkable career of the *Emden* and her destruction by the Australian cruiser *Sydney;* the cruise of Von Spee's squadron from China to South America, its defeat of Craddock at Coronel, and its destruction by Sturdee's battle cruisers off the Falkland Islands.

Maintenance of Control of Sea

Returning now to the primary fleet function, let us inquire how it is executed. Up to the present, its execution has required, in the sea zone of interest, ships of maximum offensive and defensive power, that is, battleships. These have been supported, it is true, by numerous smaller and swifter ships, such as cruisers and destroyers, and by auxiliary vessels, such as mine layers, mine sweepers, colliers, and supply ships. The real control of the sea has been won and held, however, by the mailed fist in the form of battleships. That this type of vessel still is relied upon to perform this primary fleet function may be inferred from an examination of current naval building programs throughout the world. It has been many years since as many battleships have been simultaneously under construction as at present.

Claims for Airplanes

Nevertheless, there are many laymen and a considerable number of naval experts who hold that the day of the battleship, if not entirely past, is on the wane, and

that hereafter aircraft will challenge the ability of battleships to control the sea and indeed may supplant surface ships in the execution of this duty, or at least relegate surface navies to roles of relatively small importance. These predictions are based on the admittedly great improvements in aircraft during the last 20 years; they cannot be dismissed merely by pointing to the comparatively minor achievements of naval aircraft during the World War.

To illustrate this argument for the air, let us assume another European war to exist, with Great Britain and Germany on opposite sides. Let us also assume that Germany's air force is much stronger than Britain's, and that the British enjoy great superiority in sea power. In these circumstances Great Britain would be faced with the same naval objective as existed in the World War, that is, control of the North Sea, the English Channel, and other waters around the British Isles.

Strong advocates of aircraft might argue that under these conditions, control of these waters would be impossible by means of the naval dispositions which served during the World War. These persons might claim that, since Scapa Flow is but 475 miles from Helgoland, it would be untenable as a base for the British fleet; that naval patrol of the North Sea would be prevented by German aircraft; that by the same means the English Channel would be kept clear of British shipping; and that control of the waters around the British Isles would pass to Germany by reason of her superiority in the air. If we grant all of these claims, we should have to admit that England soon would be forced to sue for peace, thus leaving her allies to cope with German armies at the seat of land warfare in Europe.

HISTORICAL ANALOGIES

Before accepting predictions such as these, however, let us look backward and see if we can find analogous situations.

In 1872 Sir William Armstrong, a noted British artillerist, expressed the opinion that it was impracticable to provide battleships with armor heavy enough to resist the attacks of guns soon to become available. He advocated, accordingly, that battleships be done away with and that they be replaced by smaller, swifter vessels either unarmored or with very thin armor. Yet some 30 years later, in spite of the great advances in artillery during this period, there were few perforations even of mediumweight armor in either of the fleet engagements of the Russo-Japanese War. Sir William not only had overestimated the potency of the gun but also had failed to foresee the possibility of major improvements in the quality of armor. Moreover, he had reached the unsound conclusion that control of the sea can be achieved by ships of weak defensive qualities in opposition to fewer units of superior defensive ability.

About 1875 the appearance of the automobile torpedo was hailed by all navies. Torpedo tubes were adopted as standard fixtures of battleships as well as of most other surface ships. From that day to this, however, no battleship has obtained a torpedo hit on an enemy vessel, though each ship of this type has carried from two to six tubes.

During the 1880's a school of thought, called the *jeune école*, arose in France. This school held that battleships were obsolete and should be supplanted by small, swift ships designed for specialized duty. The torpedo was to be the principal weapon of many of these small craft. These views were so strong in France that they caused that country to lose its position of near-equality to Great Britain in sea power as measured by numbers of large seagoing war vessels. France went in for large numbers of torpedo boats which in service proved unseaworthy and generally unsatisfactory. About 25 years later, torpedo craft were of practically no value to either Russia or Japan in the two great fleet engagements which determined the control of the sea.

The proponents of torpedoes during the final quarter of the last century did not err much in their judgment of the destructive effect of a torpedo hit, for all ships of this period were extremely weak against this form of attack. The torpedo enthusiasts, however, did underestimate the difficulty of getting torpedoes home upon the units of an enemy fleet. Even today, when we have reliable and seaworthy torpedo craft and torpedoes of long range, it is very difficult for any surface vessel to secure a hit on an enemy ship. At the Battle of Jutland, for example, the 61 German destroyers present were able to get in just one torpedo hit on a British vessel. The *Marlborough*, which received this hit, remained in action and subsequently reached a home port in safety.

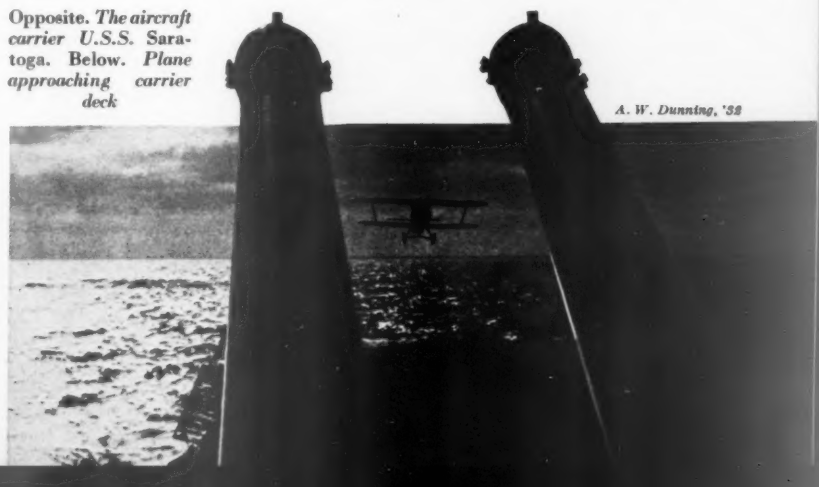
The foregoing analogies indicate the tendency of even well-informed naval experts to underestimate the difficulty of driving home an attack with new weapons and the possibility of developing countermeasures of defense. In the face of the present threat from the air we might conclude that similar errors in judgment are being made by those who advance extreme claims for the part which airplanes will play hereafter in naval warfare.

NEGLECT OF OLD WEAPONS

Yet, lest we be too hasty in dismissing the airplane as of little or no importance at sea, let us not overlook the parallel tendency to neglect weapons which have become familiar through long use, particularly if the weapons be rather unspectacular in nature.

Thus the submarine mine, which had been very effective in the American Civil War and particularly so in the Russo-Japanese War (Japan lost two battleships in a single night from contact with mines), was not the cause of much concern to naval powers in 1914. The offensive possibilities of mines had not been explored

Opposite. *The aircraft carrier U.S.S.* Saratoga. Below. *Plane approaching carrier deck*



A. W. Dunning, '32

fully, while defensive measures against them had been neglected. The experiences of the World War served to refresh men's minds about the potency of these hidden menaces to all surface and submarine craft. The collapse of the Gallipoli campaign is attributable largely to the use of mines by the Turks.

The submarine is another example of the neglect of familiar means of offense. This type of war vessel has had a long and checkered career. Used first by the United States in the War of Independence, it has offered a fruitful field to inventors all over the world. Prerequisites to the practical development of this type, however, were the automobile torpedo, the electric motor, the electric storage battery, the periscope, and the internal-combustion engine. It was not until the early years of this century, therefore, that submarines were taken at all seriously as naval vessels. Even then the technical troubles to which they were subject were so great that development was slow. Just before the outbreak of the World War few naval officers had great confidence in submarines. At that time no naval power was prepared either for adequate defense against submarines or for their full offensive use. But a few years later the greatest naval power of them all was almost brought to her knees through attacks of submarines on her commerce.

Manifestly, in the light of such experiences it would be foolhardy for any naval power to dismiss lightly the predictions of proponents of aircraft. Rather it would seem wise to weigh these predictions with care and to bend every effort toward the maximum offensive use of aircraft and the most effective defense against them.

United States Navy

U.S.S. **Ranger,** ***the newest aircraft carrier now in service***

MEANS OF ATTACK FROM AIR

The principal means whereby aircraft may attack surface ships are torpedoes and bombs.

Since a modern torpedo weighs from a ton to a ton and a half, planes of large size are required for torpedo attack. At present a plane may be expected to carry but one torpedo. To launch it, the plane must come close to the surface of the sea and within perhaps 10,000 yards of its enemy. Thus the plane presents a rather easy target and runs great risk of destruction by gunfire. At the same time the surface ship has the opportunity to dodge the torpedo by changes in course or speed. It may be said parenthetically that the dodging of torpedoes, as demonstrated by Jellicoe's battleships at Jutland, is by no means impracticable.

The second means of attack, the bomb, may be classified broadly into two groups: (*a*) the armor-piercing bomb, which has a very heavy, strong case but only a small charge of high explosive; (*b*) the demolition bomb, which has a light case and a large charge of high explosive — perhaps as much as 50 per cent of the total weight.

The first type of bomb is intended to penetrate the armored deck of a battleship and then explode. To succeed in such an attack the bomb must be very heavy — at least 1,000 pounds in weight — and must be dropped from a height of perhaps 20,000 feet or more. Hence even though the plane be large, the number of bombs must be small and the percentage of hits very low indeed. Furthermore, no damage will be done unless a direct hit is scored. It is to be noted that even if a hit is made on a battleship by a bomb dropped from a height of 20,000 feet, the ship is unlikely to be disabled, for it is equipped with at least two armored decks, both of which must be penetrated before vital parts are reached.

The second type of bomb, the demolition bomb, may be dropped from a height as low as that to which the plane dares to descend. This probably will not be less than 10,000 feet * if the target ship has efficient antiaircraft guns. In case of a direct hit upon a heavily armored ship, the damage will be less severe than that caused by an armor-piercing bomb. On the other hand, near hits will do damage to the underwater hull of the ship, similar to, but less extensive than, that caused by a torpedo hit.

UNDERWATER EXPLOSIONS

To understand the kind and extent of damage inflicted by a torpedo hit or by a demolition bomb landing near the side of a surface ship, one must consider the detonation under water of a charge of high explosive. The conversion of the explosive into gas at high temperature and pressure is not instantaneous. It progresses at an extremely rapid rate outward from the detonator, which is near the center of the charge. When the surface of combustion reaches the case of the charge, a violent blow is delivered to the surrounding water with the result that an elastic pressure wave is set up in the water. This wave travels out (*Continued on page 136*)

* Under favorable weather conditions the plane may use dive-bombing technique, by which it approaches much closer to the target and relies on the elements of surprise and speed for its chance of survival.

M.I.T. Photo

FIG. 1

Work of teredos. A block cut from damaged wood. Average diameter of the holes is about ¼ inch. Note the white, limy lining. The passages do not intersect

They Attack Wood

Living Agencies of Timber Destruction

By Charles H. Blake

The Activities and Distribution of Fungi, Termites, Powder-Post and Deathwatch Beetles, of the Shipworm, the Gribble, and the Carpenter Ant

TERMITES and the other organisms that destroy wood may be thought of as causes of timber diseases. Following out this simile one might import into the discussion many medical terms: diagnosis, prophylaxis, and therapeusis, portal of entry, and others — even prognosis. I am here concerned particularly with causation, diagnosis, and the effects of environment. I venture to suggest that in the future the details of environment will assume increasing importance as indicators of danger from wood destroyers, especially subterranean termites. In this article, attention will be confined chiefly to the living organisms destroying wood in North America. For practical reasons I shall further confine myself to those agencies which cause deterioration or destruction in sound wood and shall ignore those which are able to cause only further damage to wood already injured.

The types of wood-destroying organisms found in the tropics are the same as those of temperate regions. I know of no additional types there. Wood is destroyed faster in the tropics because there are more individual organisms at work and, due to higher temperatures, they work longer and faster. The working season in our latitude may be five to seven months a year, while in the tropics it will be a full year. Heated houses, however, simulate tropical temperature conditions.

In addition to the formal zoölogical and botanical classification of the wood-destroying organisms, there are a number of other classifications which may be used,

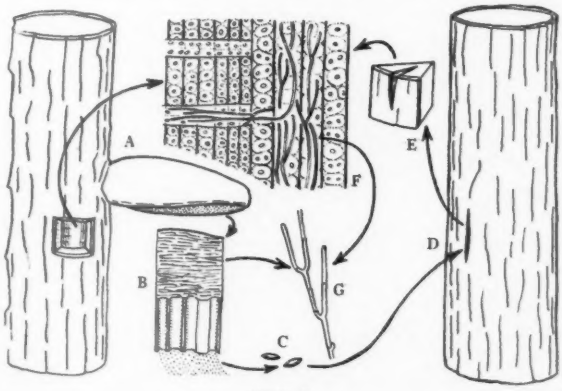


FIG. 2

Life history of a bracket fungus. A. The fruiting body on a tree. The window in the tree shows where the vegetative threads are hidden. (F shows these threads in a wood section, very highly magnified.) B. A vertical section through the fruiting body (magnified) to show the flesh above and the tubes below. Each tube is lined by a spore-producing surface from which the spores fall. C. The spores very highly magnified. D. The spores enter the deep check shown here and give rise to a new set of vegetative threads. E. Part of the same check as in D to show that it extends through the bark and into the wood itself. F. The vegetative threads in a wood section. G. The threads isolated from the wood and more highly magnified

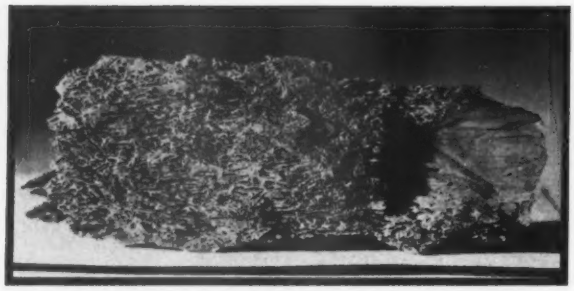


FIG. 3

Gribble work. This specimen is about ½ inch thick with a sound back surface. The holes are nearly parallel to the outer surface and about 1/16 inch in diameter

and three of these are employed in the present article. The first is environmental: Is the wood surrounded by sea water, fresh water, or air? The second depends on the use made of the wood by the organisms. The third, illustrated by the beetles, is based on the persistence of attack by a given species of insect.

Attack in sea water, as by the gribble and the shipworm, is, of course, well known. So also is attack on wood in air by fungi, termites, beetles, and so on. Attack on wood in fresh water is rare and unimportant. I have heard of but two cases, one in the Great Lakes due to larvae of caddis flies and another in Siam due to nymphs (young stages) of May flies.

The various organisms utilizing and consequently destroying sound wood fall into two use groups. The first of these contains those which obtain nourishment from the wood. Hence their interest is primarily in the chemical composition of wood. Such are the wood-destroying fungi, the termites, the powder-post beetles, and the deathwatch beetles. The second group uses wood largely because of its physical qualities. Such organisms find in wood a substance adapted to excavation and hence suitable as a dwelling place. Here we find the shipworm, the gribble, and the carpenter ant.

The fungi that decay wood belong predominantly to the mushroom group and particularly to that part of the group which produces as its fruiting bodies the familiar shelf, or bracket fungi (Fig. 2).* Lumbermen call these fruiting bodies conks. They are common on trees and stumps, and are pore fungi, that is, the undersurface of the bracket consists of the mouths of many small tubes arranged in the fashion of a honeycomb. The spores from which new plants will come are formed inside these tubes. They may drop from the tubes and be carried from place to place by the wind or by animals.

The actual damage is done by a less familiar part of the fungus, a quantity of fine, whitish threads which permeate the wood, following the tubes in it and dissolving the wood substance. By this means the fungus secures the food necessary to produce more threads and, eventually, the fruiting bodies. Since the fungus also needs water, it is evident why really dry wood does not decay. These fungi naturally attack exposed wood, even in living trees, and almost any piece of lumber is likely

* I am greatly indebted to Professor Irving H. Cowdrey, '05, and to the New England Museum of Natural History for the generous loan of specimens of injured wood.

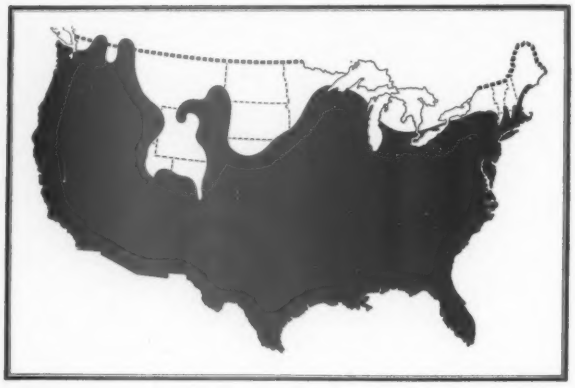


FIG. 4

Distribution of subterranean termites in the United States and Canada shown by the black area

to be infected but not necessarily damaged. The infection may lie dormant a long time if the wood is not damp enough for growth of the fungus.

While probably all of the timber woods in common use in North America are attacked by fungi, some are far more resistant than others. Heartwood is in general more resistant than sapwood. It is also of interest that some fungi (the building *Poria*, for example) attack many kinds of wood, while other fungi are restricted to attack on one or a few kinds. The same sort of differences may be found in the case of insect attack.

Turning to the animal agencies we begin our consideration with the shipworms (teredos and their close relatives). These are oddly shaped clams, whose shells cover but a small part of their bodies, leaving uncovered the very long neck. The shipworms attack only wood which is nearly or quite continuously submerged in sea water (very rarely brackish water). Adult teredos in the vicinity discharge swimming young, some of which may be fortunate enough to make contact with a wood surface in a short time. Into this they bore, using the two shells. As the hole deepens, the animal grows its neck just fast enough so that the tip stays at the surface of the wood. Through this neck the shipworm takes in food, water, and oxygen and through it also discharges

FIG. 5

Work of the eastern subterranean termite in the sill of a house. Note the concentric arrangement of the passages due to leaving the harder summer wood in each annual ring. The knots are also not attacked

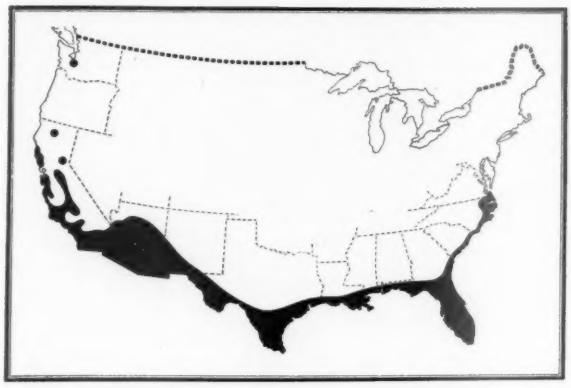


FIG. 6

Distribution of dry-wood termites in the United States shown in black

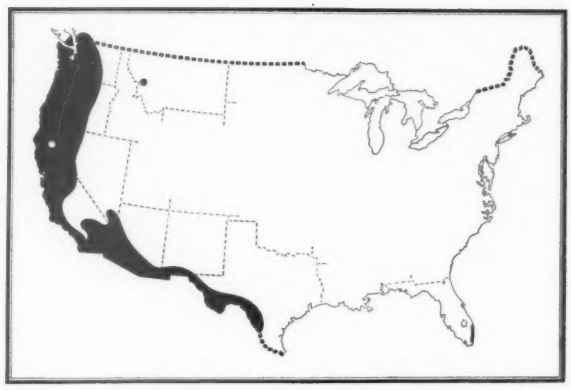


FIG. 7

Distribution of damp-wood termites in the United States and Canada shown in black

wastes, including the excavated wood. Teredo work may be recognized by the limy lining of the hole in the wood (Fig. 1). The numerous sorts of shipworms occupy as a group the temperate and tropical seacoasts of the world. So far as known no wood is immune to their attack if they are given time enough. Another group of clams, *Martesia* and the other piddocks, may have a more local significance in the infestation of marine structures.

The other important wood destroyer in the sea is a somewhat shrimplike, gray animal about 3/16 of an inch long, the gribble (*Limnoria*). As a wood destroyer it is best known in the northern seas where it bores small holes (about 1/16 of an inch in diameter) in the outer half inch of the wood (Fig. 3). As this damaged wood is broken away, the animals bore into the fresh wood underneath. The exact food of the gribble seems to be unknown. It is my personal opinion (without real evidence) that it consists of minute marine organisms and not wood. Another shrimplike animal (*Chelura terebrans*) about the size of the gribble is now attracting attention. It definitely occurs in holes in wood, but whether it can attack sound wood is not certain.

The remaining wood-destroying animals belong to that great assembly of six-legged and usually winged animals known as insects. While nearly all the wood-boring insects are terrestrial, we have already seen that some may attack wood that is submerged in fresh water, and one species — the Dutch wharf beetle — has achieved a somewhat exaggerated reputation for damaging marine structures. The fact is that this beetle uses softened and damp wood and is indifferent to the location of the wood. It may be found in damp and partly rotted timbers of buildings inland, or in wharf piles or boats where the softening is due to sea water. It is to be regarded as a secondary invader of injured wood.

By and large the most famous and important members of this group are the termites (popularly and rather poorly called white ants). Generally a termite colony consists of three sorts of individuals, each having its special work to do: First, there are the fertile or reproductive individuals who produce more termites. Second, there are the workers who chew the wood, build the nests, or excavate the galleries, and raise the young. This is a sterile type and normally the most numerous in the colony. It is generally wanting in dry-wood and damp-wood termites, where its place is taken by the young stages of other castes. The third type is the soldier, a defensive and sterile caste, showing great development of the jaws or of special head glands.

The subterranean termites excavate dwellings which consist of passages in the earth that are connected to passages in the wood (Fig. 5). This sort is represented in North America by a number of similar species occupying practically all of the United States, a little of southwestern Canada, and southward through the tropics (Fig. 4). The ability of some of the species to range into comparatively cold climates is doubtless connected with their habit of withdrawing into the earth during the winter, whereby they are protected against the worst rigors of the weather.

I have already noted the probable importance of environmental detail in determining the liability of wood to attack by borers. The eastern subterranean termite is a good illustration. I have had the opportunity to examine scrutinously the northeastern portion of its range. A general northern boundary may be drawn which follows an average winter isotherm of about 21 degrees F. and an average summer isotherm of 65 degrees F., depending on which is the more southern. (This line is very close to Hopkins' equivalent isophane of 50 degrees.) Within this general area we find the species, almost without exception, on nonalkaline, well-drained, sandy or gravelly soils. This termite is definitely wanting on areas in New England having alkaline, or heavy, poorly drained soils.

The dry-wood termites are found in the southern United States and southward. Their range extends northward near the coasts to about San Francisco, Calif., and to Norfolk, Va. (Fig. 6). Their nests are made in sound, dry wood, often at considerable height aboveground, and passages do not extend into the earth.

The damp-wood termites attack wood which is damp but not necessarily rotted. They may attack sound wood in shaded spots or near the ground, but the nest does not extend into the earth. Such termites are found in North America west of the Rockies from extreme southwestern Canada south to Mexico, and in coastal southeast Florida (Fig. 7).

In North America the place of chief importance among insects that damage wooden structures is held by termites, while in Europe this place is taken by beetles. The most important of these pests in northern Europe is a long-horned beetle, the "house beetle," which Trägårdh refers to as "house enemy No. 1" in Sweden. It is scarcely known in this country.

The important beetles that attack wood are classified as a considerable number of species in several families. Their work agrees, however, in consisting of rather uniform, tapered holes ending at the surface of the wood in exit holes from which the adult beetles emerge. The damage is done almost entirely by the young, or grubs. The holes are largely filled by a sawdustlike wood powder called frass.

We may conveniently arrange the timber beetles into four persistence groups in order of increasing importance: (1) Accidental pests, such as larder beetles. (2) One-generation pests, or those which attack green timber but which may not finish their growth until after the timber has been seasoned and even used for building. A second generation does not occur in the same timber. Examples are certain longhorns and flat-headed borers. (3) Bark beetles, which infest only sapwood under bark. The infestation persists as long as sapwood is available under bark. Such are engraver beetles and some deathwatch beetles. (4) Permanent pests, by which attack may be initiated in barked, seasoned timber.

The more destructive families are those of the deathwatch beetles, the false deathwatch beetles, and the powder-post beetles. The members of these four families may breed generation after generation in the same piece of wood, resulting ultimately in a destruction as complete as that due to termites. Members of a few other families are also known to attack seasoned wood.

The family of deathwatch beetles is better known in Europe than in America. It received its popular name from the ticking sound made by the beetles in the wood — a sound formerly regarded as an ill omen. Both hardwoods and softwoods are injured by this family. The false deathwatch beetles (two families) are somewhat larger than the true deathwatches and work almost entirely in seasoned sapwood of broad-leaved (deciduous) trees. The deleterious activities of this family are most conspicuous in the southwestern United States. The famous "short-circuit bug" of California is a member of one of these families. The powder-post beetles attack hardwoods only and are most frequently reported from ash, oak, and hickory (Fig. 8). Given sufficient time, practically the whole of the inside of a piece of wood will be reduced to a fine sawdust.

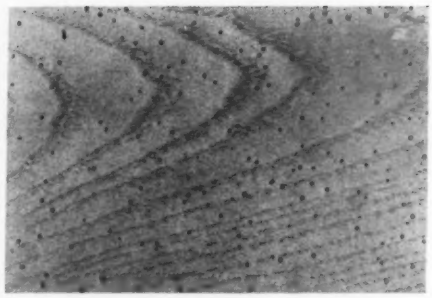


FIG. 8 (ABOVE)

Surface of an oak board infested with powder-post beetles. The exit holes are shown. They have a diameter of about 1/16 inch

FIG. 9 (BELOW)

Half section of part of a pole worked by carpenter ants. The true height of this specimen is 11 inches

It is known that the food of the young of these beetles is the starch in the wood. Some work has been done abroad in attempting to remove the starch without injuring the wood. If successful, this will prevent infestation by powder-post beetles, since the females do not lay eggs in starch-free wood. Very recently an experimental apparatus has been set up in the Institute's biological engineering laboratory which may lead to a means of disinfesting small objects by the use of high-frequency radio waves.

The last wood-boring insects on our list are the wasplike insects. The most important of these is the carpenter ant — a large black ant which excavates a series of broad passageways to serve as a dwelling in wood (Fig. 9). Wood attacked by this ant is usually damp and often already somewhat rotted. Ants are easily distinguished from termites by their narrow, wasp waists. The carpenter ant is widespread in the cooler parts of North America and Europe. In addition to ants, certain other wasplike insects cause damage. The carpenter bees, for instance, which are mostly black and as big as large bumblebees, make nests for their young in wood. Another family, known as wood wasps, or horntails, has larvae which bore in wood. These wasps are one-generation pests, and most damage from them is reported from northern Europe.

This brief review does not take account of other deleterious impingements of living organisms on engineering materials. More or less is known about the subject in its relation to electrical cables, stone brick, and concrete. Each of these materials warrants investigation.

It has been my aim in this account to draw a broad outline around the subject, coming only to the more general conclusions. One further conclusion may be drawn from the illustrations. Within rather wide limits the cause of timber destruction may be determined from the damage to the wood without isolation of the causative organism. The investigation of life histories, habits, and geographical distributions of these organisms furnishes the foundation upon which rational methods of treatment and prevention of attack are based.

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Invisible Glass

UNDER a bell jar, evacuated to a millionth part of an atmosphere, a fine wire strung between contacts glows red hot, white hot. The midsection is twisted into a little cup, in which a pinch of white powder rests. It may be sodium fluoride or lithium fluoride or cryolite or another mineral of a rather large group. Clipped in strategic positions to a frame within the bell jar are strips of glass. Unseen, the molecules of the melting powder speed through the vacuum, evaporated, and are laid down in an imperceptible, transparent film upon the strips of glass. The thickness of the precipitated layer is controlled within extremely delicate limits by conditions maintained inside the bell jar and by the time of precipitation allowed.

Remove the strips of glass after treatment and they seem little changed, except that they are more difficult to see. A strange change, however, has occurred in what they do. Whereas before treatment each surface of the glass reflected four per cent of the light which struck it, so that only 92 per cent was transmitted, the glass which has been given a fine skin of sodium fluoride — a skin only a quarter of a wavelength of green light in optical thickness (a geometrical thickness of about four-millionths of an inch) — transmits 99.6 per cent of the light striking it. Such glass is, to all intents, invisible, for it casts back into the observer's eyes practically no reflection. Another strip, similarly treated but with a different precipitant, such as stibnite, is altered equally in the opposite direction; its powers of reflection are tremendously increased and in addition may be made selective, so that it reflects light of a certain wavelength only, transmitting other wavelengths. Thus red passes through it and green is reflected from it.

The principle involved in the elimination of reflection is that the refractive index — or measure of reflecting power — of the film can be made intermediate between that of air and glass. The reflections from the two interfaces are then of equal amplitude, and when the optical thickness of the film is one quarter of the wavelength of light, the two amplitudes cancel each other. The light that would normally be reflected is added to the transmitted light. The refractive index of ordinary glass is 1.50, so the refractive index of the film should be about 1.25. This is lower than that of any fluoride crystals, but when a fluoride crystal is deposited by evaporation, the resulting film has a lower index of refraction than that of the crystal. For example, crystalline sodium fluoride has an index of refraction of 1.33. The films evaporated in high vacuum have an index of about 1.28. If the evaporation is carried out with air present, the index of refraction of the evaporated film can be arbitrarily lowered by choosing the appropriate air pressure.

The thickness of the layer of sodium fluoride deposited determines the amount of decrease of reflection attained. Decrease of reflection of course means increase of transmission, and for some of the possible uses of the glass this increase is the important thing. For other possible uses, however, decrease of reflection — the negative side of the picture — is the end sought. The number of materials that can be deposited by evaporation is very great, and many of these materials have the desirable hardness and insolubility, as well as the desirable optical characteristics.

In optical equipment, for example, for applications in which the films now secured are of sufficient durability, the flare of lenses — that is, the creation of false images because of reflection — may well be eliminated by the treated glass. Flare decreases as the square of the reflecting power, so that a loss of ten points in reflection cuts down flare by one hundred. The practical utility of the reduction of flare is suggested by the fact that in lenses used by military aviators flare has been found to make accuracy in night bombing extremely difficult to secure.

In the fine arts, use of the "100 per cent" glass instead of ordinary glass for covering paintings will eliminate once and for all the annoying reflections that often stand between the observer and the picture he has traveled far to see. The curving glass display windows now installed by some stores, which depend upon curved surface to shoot their reflections into absorbing wells, may in due course be replaced by flat sheets of the treated glass, once means have been perfected for putting a tough skin of molecules over the flaky film which cancels reflection.

Another application at first thought far more remote than these, yet actually of possibly far greater significance, is in devices designed to receive solar energy to be converted into useful power. Here the old principle of the greenhouse comes into play. If sunlight strikes the new glass, it may

Each summer, as described on page 132, a group of Technology students make an industrial tour of Europe. Here is last summer's group climbing Furka Pass, Switzerland

be transmitted with 100 per cent efficiency into an insulated area. Some of the light waves themselves may be reflected from the receiver back through the glass; but the light that has been transformed into useful heat — long-wave radiation — cannot thus go back, since glass is opaque to waves of such length. The new glass therefore is of pronounced importance, inasmuch as it permits the trapping of all the sunlight reaching a given area, none being lost by reflection.

This interesting new development has been under way in the laboratories of the Institute's Department of Physics for some months. C. Hawley Cartwright and Arthur F. Turner, '29, instructors in that Department, have been carrying on the work with the aid of the color analyzer built by Professor Arthur C. Hardy, '18.

Dean of Architecture

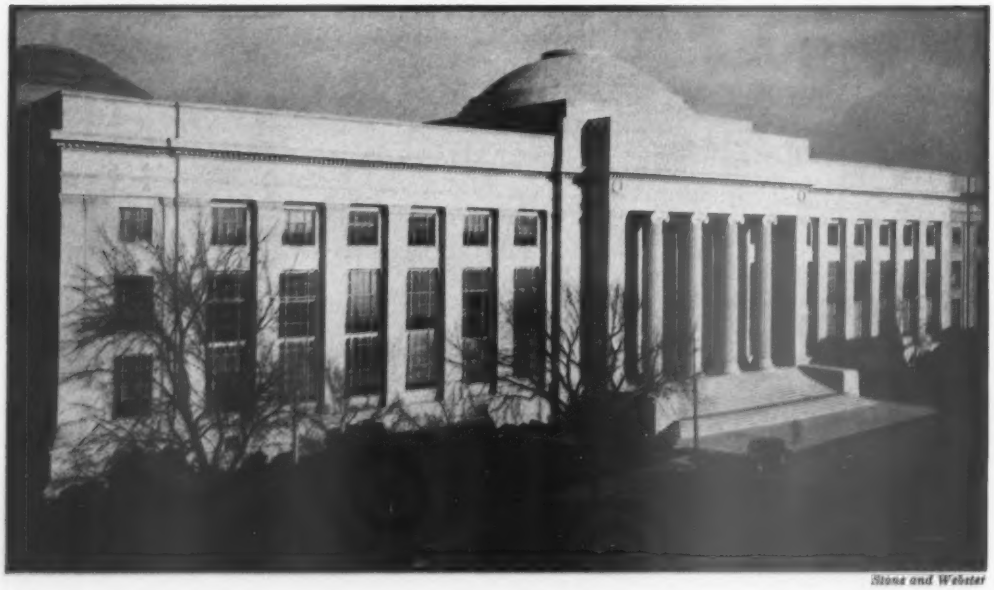
A MEMORABLE reception by President Compton and the Corporation in honor of Dean William Emerson and his colleagues in the School of Architecture followed by but a few weeks announcement of Dean Emerson's retirement next autumn and the appointment of Walter R. McCornack, '03, of Cleveland as his successor. Dean Emerson has been head of the Institute's School of Architecture since he joined the Faculty in 1919 after a notable career in architecture in New York, where he had specialized in the design of bank buildings and model tenements. The reception on the evening of December 12 was expression of appreciation of the contribution he has made to Technology in the years of his administration, and served as well to introduce those attending to the facilities of the new quarters of the School, whose direction in the fall will be assumed by Mr. McCornack.

The newly appointed dean, who is noted for the design of school and college buildings, is a native of Oneida, Ill., and was educated at Knox Academy and Knox College at Galesburg, Ill., and at our own School of Architecture. Early in his career he was associated with the late Guy Lowell, '94, in the development of plans for the Boston Museum of Fine Arts. Later he was engaged by the Worcester Art Museum for preparation of a program and preliminary plans for the museum building. One of his important contributions in the design of schools followed his appointment by the Board of Education of Cleveland to direct its $40,000,000 school building program, which was completed in 1925. Another important project for which he was consulting architect was the Southern School Building and Industrial College Program of the Julius Rosenwald Fund.

The Board of Education of New York City in 1936 named Mr. McCornack a member of a commission of five architects to study the school building problems of New York City and to make recommendations for the improvement in planning, design, and construction methods. He has designed schools and college buildings in Illinois, Ohio, Virginia, Kentucky, and Connecticut. Since 1930 he has devoted himself principally to housing, a notable example of which is Cleveland Homes, Inc., a public works slum-clearance program.

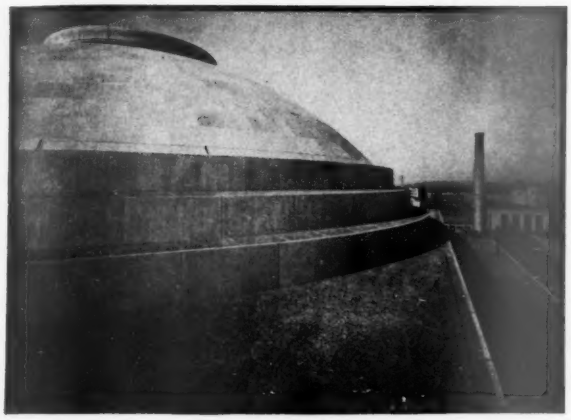
In 1932 Mr. McCornack was a member of the committee on large-scale housing of President Hoover's conference on Home Building and Home Ownership. He is a member of the United States Chamber of Commerce and of its construction and civic development committee. Active in civic affairs in Cleveland, he is a member of the city plan committee and of the building code committee. In 1937 he was appointed by the mayor of Cleveland as chairman of the board of review of the Electric Code, and he has been a member of the city's slum clearance committee since 1933.

Mr. McCornack has been a lecturer at various universities, including the schools of education of the University of Chicago, Yale University, Ohio University, and at Peabody College in Tennessee. He has also lectured at the Case School of Applied Science on the lighting problems of schools and has given a yearly course of lectures on professional practice at the Cleveland School of Architecture at Western Reserve University.

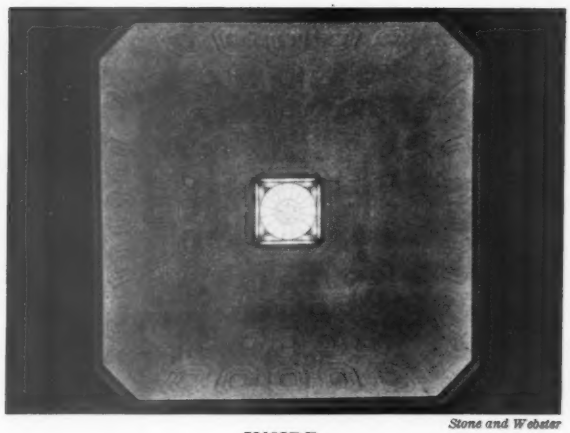


Stone and Webster

The William Barton Rogers Building impressively lighted by the afternoon sun. At a colorful reception on December 12 (see above) it was inspected by 700 guests invited to greet Dean William Emerson and his colleagues of the School of Architecture



OUTSIDE



INSIDE

Stone and Webster

The dome of the William Barton Rogers Building (see opposite)

In announcing the retirement of Dean Emerson and the appointment of his successor, President Compton, remarking on Dean Emerson's notable contributions to the School of Architecture, pointed out that "just as Mr. McCornack comes to us with an outstanding background in the field of housing, so, too, Dean Emerson, when he became head of our School of Architecture in 1919, left a distinguished practice in New York which had as one of its major emphases work in the model-tenement field. This interest in housing, Dean Emerson has never relinquished; early he foresaw the coming importance of city planning and took the steps which have led to our present effective effort in this direction; while as recently as 1934, consistent with his lifelong attention to civic responsibility, he served as chairman of the Boston Coördinating Housing Committee.

"Dean Emerson has represented the Institute with distinction in the councils of the American Institute of Architects, having been a first vice-president of that society and for many years chairman of its important committee on education.

"To the School of Architecture itself, in addition to assiduous attention to the problem of maintaining the highest grade of personnel, he has made many other contributions. He has been responsible for a splendid enriching of the library of the School and of the art collections, both through his own generosity and through his many influential connections. It was he who engendered and brought to pass the idea of the student commons room, so important a feature in the life of the architectural students, an achievement which was recognized by the students themselves when last year they offered the petition which has resulted in our new commons room being known as the William Emerson Room.

"A graduate of the École des Beaux Arts and a lifelong friend of France, during the War, Dean Emerson, as would have been expected, rendered energetic service to the Allies in France. As major and director of the American Red Cross Bureau of Construction in Paris from 1917 to 1919, he served with such distinction as to win the ribbon of a chevalier of the Legion of Honor. It was but natural that this long and stimulating contact with France should have led him to bring to our School in succession two of the most distinguished French teachers of design who have come to these shores, Professors Ferran and Carlu. It was equally characteristic that five years ago he was one of the first to see that America need no longer look to Europe for fundamental architectural stimulus and one of the first to take the then radical step of appointing a brilliant young American as head of design.

"But an appreciation of Dean Emerson would be inadequate if it were to rest on his achievements in the academic, professional, or public-service fields. He has had a steady and continuing interest in the personal problems of his students. He and Mrs. Emerson have frequently assisted them over rocky points in their paths and have consistently cloaked these activities in anonymity. The congenial atmosphere of their home they have always extended to them. Dean Emerson has maintained an active interest in their subsequent careers, has had a unique knowledge of what each man has done, and has regularly been able to assist them to positions where their professional attainments would have greater opportunity to take effect.

"In the final analysis the test of a great teacher and a great administrator is found in the degree of coöperation and affection he commands from his staff. By this test there can be no question of the place Dean Emerson has occupied in the field of architectural education."

THE 700 guests who attended the reception for Dean Emerson and his colleagues were received in the great rotunda of the new William Barton Rogers Building, where a specially designed setting formed the background for one of the most colorful and distinguished events at the Institute for many years. Those who were invited to join President and Mrs. Compton in receiving the guests were Dean and Mrs. Emerson; Dr. Vannevar Bush, '16, and Mrs. Bush; Edwin S. Webster, '88, and Mrs. Webster; Philip Stockton, '99, and Mrs. Stockton; Charles D. Maginnis, President of the American Institute of Architects, and Miss Alice Maginnis; John T. Whitmore, '18, President of the Boston Society of Architects; Professor Harry W. Gardner, '94, and Mrs. Gardner; Professor Emeritus W. H. Lawrence, '91, and Mrs. Lawrence; and Professor F. J. Adams and Mrs. Adams.

Commonwealth of Technology

Faculty Club ss. The Hotel Continental Court

To

Vannevar Bush

Greeting

You are hereby

Summoned

to be and appear personally and to appear before our Justices of

The Hotel Continental Court

to be holden at Cambridge within and for our County of

Faculty Club

for unjust business

on Tuesday the Sixth Day of December A.D. 1938

at forty five minutes past six of the clock in the evening

then and there in our said Court to answer a

Bill of Complaint

wherein you are charged (malevolentio et stultia) with Premeditated and Unconscionable Assertion and whereby an Injunction is prayed.

Herein Fail Not under pains and penalties and have

you there this summons with your doings thereon.

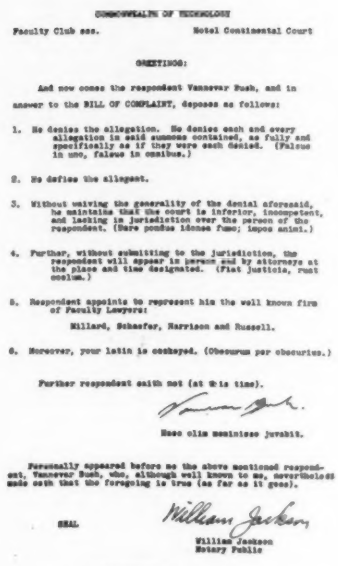
Witness Carle R. Hayward Esquire

at Cambridge the 29th day of November in the year of

Compton the eighth

Attest Archibald D. Fiskin

SUMMONS



COMMONWEALTH OF TECHNOLOGY

Faculty Club ss. Hotel Continental Court

GREETINGS:

And now comes the respondent Vannevar Bush, and in answer to the BILL OF COMPLAINT, deposes as follows:

1. He denies the allegation. He denies each and every allegation in said summons contained, as fully and specifically as if they were each denied. (Falsus in uno, falsus in omnibus.)

2. He defies the allegant.

3. Without waiving the generality of the denial aforesaid, he maintains that the court is inferior, incompetent, and lacking in jurisdiction over the person of the respondent. (Dare pondus idonea fumo; impos animi.)

4. Further, without submitting to the jurisdiction, the respondent will appear in person and by attorneys at the place and time designated. (Fiat justicia, ruat coelum.)

5. Respondent appoints to represent him the well known firm of Faculty Lawyers:

Millard, Schaefer, Harrison and Russell.

6. Moreover, your latin is cockeyed. (Obscurum per obscurius.)

Further respondent saith not (at this time).

Vannevar Bush.

Hoc olim meminisse juvabit.

Personally appeared before me the above mentioned respondent, Vannevar Bush, who, although well known to me, nevertheless made oath that the foregoing is true (as far as it goes).

SEAL

William Jackson

William Jackson
Notary Public

ANSWER

When the Faculty said its farewell (see below) to Dr. and Mrs. Bush at the annual fall dinner of the Faculty Club in Cambridge on December 6, it indicated its affectionate regard for them in a jovial mock trial in which Dr. Bush was arraigned on a charge of deserting the Institute to become president of the Carnegie Institution of Washington.

In the trial, after Dr. Bush had presented his defense, a court that was scientifically packed, by unanimous agreement found him guilty. Prosecuting Attorney William H. Timbie was pitted against a formidable array of attorneys for the defense. However, the combined cunning of law, chemistry, physics, and civil engineering represented in the qualifications of Professors Albert A. Schaefer, Earl B. Millard, George R. Harrison, and George E. Russell, '00, was of no avail. Having produced a "lie detector," an outrageously weighted pair of scales, and a slide rule, Justice Karl T. Compton found Dr. Bush guilty of desertion. As part of his sentence he is required to return to the Institute from time to time to revisit the scenes of his early endeavors. A very versatile dairy cow was the end result of the skit in which Professor William C. Greene of English and History played the part of Dr. Bush in the application of engineering to dairying

Guests at the reception had the first opportunity to inspect the new facilities of the School of Architecture. There were several exhibitions, including drawings illustrating the history of architectural education from 1880 to the present. Another exhibition presented examples of contemporary student work, as well as models and various examples of textiles, veneers, and structural materials representing the resources of various fields from which the architect draws in the practice of his profession. The Division of City Planning had a separate exhibition presenting problems of various phases of city planning, including a regional plan of the metropolitan district of Greater Boston. There were also projects covering transportation and recreational areas.

Oasis

YOU have here an oasis in the midst of a dismal world: a domain where reason, and true accomplishment, and good-fellowship reign; where no one gives any orders — which the hard-boiled businessman cannot understand — and where it doesn't even make much difference what rules are passed by the Faculty; where there can be lively disagreement without rancor, and keen competition without disappointment; where one does for another not by compulsion, not even because it results in aid given in return, but just because it is a pleasant thing to do; where the peculiarities and idiosyncrasies of us all add to the zest of life and cause no pain; where scientific generosity, that fairest flower of the day, flourishes and sheds its perfume to encourage those who accomplish and those who merely try; where the very atmosphere stifles prejudice before it is born; where youth is taught to value all these things and to hold the torch high; where much is accomplished for the welfare of mankind, and more for the great good of man's soul; where honors rest lightly and disappointments evaporate with the advent of every spring.

"You have an oasis, presided over by one who exemplifies these virtues in his every act. Long may you regard it as a holy place."

With these words Vannevar Bush, '16, said formal farewell to his Institute colleagues at the fall dinner of the Faculty Club last month (see illustrations adjacent), describing truly and simply the spirit of Technology to which — as no one realizes better than those colleagues — he himself has contributed so greatly as teacher, administrator, and man.

Though the meeting was one of farewell, it was also one of celebration — celebration to take the edge off regret, and celebration to express the pride Dr. Bush's associates feel in his selection for so distinguished and influential a post as that of president of the Carnegie Institution of Washington. It was, in the round, the best Faculty Dinner we have attended — the best conceived, the best in friendly spirit. Dr. Bush's talk reflected that spirit and voiced it in terms of a charter and an assurance for the future.

Alumni Aid in Student Selection

BY B. ALDEN THRESHER
Director of Admissions

IN an institution such as Technology, the Alumni form an important part of the machinery for the selection and admission of students. The keymen in this work are the 175 Honorary Secretaries in cities throughout the United States and in some 20 large foreign centers.

The Honorary Secretary is an Alumnus carefully selected by reason of his loyalty to the Institute, his standing in his community, and his interest in young men. Each Honorary Secretary is appointed directly by the President and holds office for a five-year term. His function is to serve as a local point of contact with prospective students and with the schools in his community. He talks personally with candidates for admission, advises them in the light of his own Institute background and subsequent experience, and supplies to the Admissions Office comments upon their apparent promise as Technology students.

The Admissions Office receives inquiries from a very large number of prospective students each year. In practice, it proves impossible to distinguish purely casual inquiries from those which sooner or later result in a bona fide application for admission. For this reason, *all* inquiries from each district are referred to the appropriate Honorary Secretary. A letter replying to the inquiry and sending information about the Institute goes to each correspondent, referring him to the local Honorary Secretary. A copy of the answer is sent to the latter, so that he will be informed of all inquiries originating in his territory. It is made clear to the student that, should he decide to apply for admission, he is expected to take the initiative in arranging a conference with the Honorary Secretary. This Alumnus cannot be expected to serve as a scout to hunt up prospective students. His function is to aid in the selective process, by which the most promising candidates are chosen, not to act as a recruiting officer. It has nevertheless proved desirable to inform the Honorary Secretary immediately of inquiries in his territory, so that he can look up the student if he wishes to do so.

Letters from the Honorary Secretaries now constitute an important part of the whole body of evidence available to the Committee on Admissions in selecting the candidates to be accepted for the entering class. Such letters reflect the mature judgment of men experienced in appraising human nature. They form an invaluable supplement to the record of scholastic achievement and to the other evidence available on each candidate.

The Honorary Secretary is not expected to be a source of detailed information about entrance requirements and other details, nor is he expected to make, on behalf of the Institute, commitments regarding admission or the award of scholarships. He can, however, through his contact with the schools and through conferences with students, serve as a focal point of general information and of selective judgment in the community. He provides a home-town opinion on candidates. With the growing geographical diversification of the student body, the Honorary Secretary is a chief means by which the Institute keeps its roots established in every section of the country. Many other Alumni, though not officially a part of the selective organization, have rendered important service by talking with boys of exceptional promise, advising them, and putting them in contact with the Institute.

The selection of candidates for freshman scholarship awards is another important activity by which many Alumni, and especially the officers of alumni clubs, aid Technology. In 18 large centers there are now alumni regional scholarships. These are awards of full tuition for the freshman year. Candidates are selected upon recommendation of committees of Alumni in each city. Meetings of these committees, before which applicants appear for personal conferences, are held each spring. The caliber and subsequent performance of the holders of these awards testify to the care and good judgment of the alumni committees which have recommended their selection. These committees likewise aid in the award of the numerous freshman competitive scholarships of part tuition in varying amounts.

The splendidly effective work of the Alumni in these fields indicates that Technology is far more than a group of buildings and a staff: It is likewise an idea embodied in its Alumni, who play a vital part in perpetuating the spirit and ideals of education in science. Since roughly one-third of the entire student body (including the Graduate School) is new each year, the selection of the best candidates is of paramount significance. The

M.I.T. Photo

TO STUDENTS, AS WELL AS ENGINEERS, THIS IS HELPFUL

The Department of Civil and Sanitary Engineering's laboratory of structural analysis (The Review, February, page 184) has been outstandingly successful as an aid to teaching, and in addition, as a research tool. In the foreground above is a suspension bridge model under study

reservoir of experience and judgment available for this purpose in the alumni body is an asset which the Institute will continue to utilize, thanks to the wholehearted coöperation which the Alumni have offered as the system has been brought to its present development.

Technology's European Envoys

LAST summer ten Technology students and a fellow student from Middlebury College spent about ten weeks traveling 5,500 miles through ten European countries on what has proved to be an eminently successful mission of good will. The occasion was the sixth annual industrial tour of Europe, conducted by Technology's Department of Business and Engineering Administration with the generous assistance of the Thorne-Loomis Foundation, Inc., of New York City (Alfred L. Loomis, banker, physicist, and life member of Technology's Corporation).

When started in 1933, the purpose of the tour was twofold: First, a select group of students would be given a unique opportunity to study industrial conditions in European countries through a series of prearranged plant visits designed to reflect representative industries and practices in each country visited. The second purpose was to acquaint students with the cultural and historical resources of the older civilizations of northern Europe.

Six successful tours have demonstrated that a third purpose is of major importance. Apparently without exception the visit of the group is anticipated with friendly interest and pleasure in every city and town along the way. Technology men living abroad have been extremely coöperative in providing for the students' needs. Fully as gratifying has been the genuine desire of non-Alumni to aid the group in every way possible. During the past summer more than 40 men and women having no formal connection with the Institute put themselves to some trouble and expense in providing assistance or entertainment, for which the students were most appreciative. Daily, of course, countless questions must be answered about American customs, ideals, and politics, and of life and work at Technology. In effect the students have come to be regarded as ambassadors of international good will.

The trip is made in a bus, fully equipped for sleeping, cooking, and long-distance travel, provided by the Thorne-Loomis Foundation. Out-of-pocket expenses only, consisting primarily of gasoline, oil, insurance, provisions, and steamship fare, are borne by the students. Countries visited last summer were England, Scotland, Norway, Sweden, Denmark, Germany, Switzerland, France, Belgium, and Holland. A total of 26 industrial plants was visited, as well as numerous points of historical, cultural, or scenic interest in each country. Departments of the Institute represented in the group were Electrical Engineering, Metallurgy, Naval Architecture, and Business and Engineering Administration.

Tentative plans for the coming summer involve essentially the same itinerary and duration of time as last year, which the students found highly satisfactory. A new feature is contemplated, however, which is expected to add materially to the success of the tour. Following an experiment tried in Sweden during a previous trip, a qualified student from each of several of the countries visited will be invited to accompany the group during the period of visit to his native country. In this way possible language difficulties will be avoided; the students will have full opportunity to ask questions; matters of interest not readily apparent to the visitor may be pointed out; and the group will be off to a head start toward learning the ropes in the country visited.

Also for the first time the tour will be organized and run by a group of students and recent graduates, including Allen W. Horton, Jr., '36, who have made the trip in past years, while the Department of Business and Engineering Administration will contribute any necessary services and guidance. Thus, both valuable firsthand experience will be available when plans are made and a broader recognition will be accorded the success which earlier tours have enjoyed, the favorable publicity and interest in the Institute which they stimulate, and the expressed desire of students in all Departments to participate.

RHYTHM
SPEED
CONCENTRATION
CONTROL
Densmore Shute follows through
(*see next page*)

Recognition

ANNUAL awards of two professional societies are currently made to members of the Institute Faculty whose contributions to their fields of endeavor during 1938 have been distinguished. To Alfred V. deForest, '11, of the Department of Mechanical Engineering will go the Sylvanus Albert Reed Award of the fellows of the

THE ARC OF THE SWING

Professor Harold E. Edgerton, '27, has added to his repertory of high-speed photography a new multiple-image technique which makes possible photographs such as the above study of a golf stroke executed by Densmore Shute, the well-known professional. The successive images of the club and ball are separated by intervals of one-hundredth of a second, show the bending and twisting of the club and the entire course of the swing. On the opposite page is a single-image photograph taken just after impact. Note the bent shaft of Mr. Shute's club

Institute of the Aeronautical Sciences. To Erwin H. Schell, '12, Head of the Department of Business and Engineering Administration, has been awarded the Gilbreth Medal for 1938 of the Society for the Advancement of Management.

Professor deForest, who will receive his award at the annual meeting of the aeronautical institute in New York late this month, was chosen as recipient for his development of the Magnaflux method for testing metals. This magnetic testing method grew out of the observations of William E. Hoke, who in 1918 found that small iron particles tend to collect on cracks in magnetized steel parts. In 1928 Professor deForest investigated the phenomena of local magnetic poles and found that by using heavy currents through the material, the sensitivity of the test could be greatly increased. At the same time, more suitable magnetic powders for locating the poles were developed. This method makes it possible to detect forging defects, and fatigue and grinding cracks. It is also applied for the discovery of nonmetallic inclusions and small seams on, or below, the surface of the metal, as well as for locating defects in welds, particularly in airplane construction. The ability of the test to locate nonmetallic inclusions has

M.I.T. Photo

IN THE GRADUATE HOUSE

The main dining room where graduate students and Faculty may dine. Several other dining rooms are available, and noon finds many members of the staff joining the graduate students in the use of these facilities and the pleasant lounges

led to important improvements in the manufacture of steel for critical parts of engines and propellers. The Magnaflux test is almost universally applied for re-examination of engine parts at overhaul periods. In addition it is also used for railroad and automotive tests, and for examination of welded pressure vessels and tanks in the oil industry.

The Gilbreth Medal, presented to Professor Schell, is awarded annually to that person who, in the opinion of the judges, has rendered an outstanding contribution to the field of industrial engineering and management. Professor Schell is the author of two outstanding texts, "The Technique of Executive Control" and "Administrative Proficiency in Business," and has long been interested in training young men for the responsibilities of management in business and industry. Besides his books he has written numerous outstanding and progressive articles which have, through the years, constituted a series of important contributions to the science of management. Announcement of the award was made at the recent annual conference of the Society for the Advancement of Management, held in New York.

Popular Science Lectures

THE first of the annual series of Popular Science Lectures sponsored by the Society of Arts was given on December 11, when Charles S. Draper, '26, Associate Professor of Aeronautical Engineering, gave an experimental lecture on "How a Pilot Navigates the Air." Professor Draper's lecture was illustrated by instruments, experiments, and slides showing how an airplane is navigated. The second lecture of the series, "The Approach to the Absolute Zero of Temperature," will be given by Frederick G. Keyes, Head of the Department of Chemistry, on January 15. In this lecture Dr. Keyes will show experiments of extraordinary interest, including the liquefaction and solidification of hydrogen.

On February 12, Professor Frederick K. Morris of the Department of Geology will lecture on "Rocks from the Sky." He has just returned from a year's journey around the world, during which he made many interesting geological studies. The final lecture of the series, "Living Mechanisms and How the Exact Sciences Measure Their Functions," will be given by J. Warren Horton, '14, Associate Professor of Biological Engineering, on March 12.

All the lectures in this series are given in Room 10–250 at the Institute.

The Alumni Council

AS the parliament of the Alumni Association, the Council occupies an important and responsible position in Technology affairs. That this responsibility is not expressed by more discussion on the floor of the Council has been deplored on occasion, perhaps with reason, but those who have dealt intimately with alumni affairs know that the Council does effective work even though it does not indulge in spectacular parliamentary discussion.

Its effectiveness lies in its many committees, and it is in these small groups that we see at their best the loyalty and industry of Council members. The fact that Alumni Day is operated by men who have full-time responsibilities in business and the professions is one example. Another may be found in the special committee to advise on the establishment of an annual alumni fund which reports, after an exhaustive study, at the January Council meeting. And there are dozens of others.

Lending direction and coördination to these many groups stands the President of the Association, aided by the Secretary, and we have been extraordinarily fortunate in recent years in the way successive presidents have contributed of their time and competence to the management of the Association. Last year Marshall B. Dalton, '15, carried a tremendous load in overseeing the Alumni Fund Campaign and this year Harold B. Richmond, '14, is restudying our whole organization with superb understanding of its details and objectives.

These editorial remarks are by way of preamble to a brief report on the two Council meetings held this fiscal year. Meeting for its 201st session on October 31, the Alumni Council had ample demonstration of the virtuosity of Mr. Richmond who was faced that evening with a considerable mass of business, and got it all through expeditiously as well as efficiently. His address and despatch left ample time and full attention for the guest speaker of the evening, Professor Henry E. Rossell, '15, of the Department of Naval Architecture, whose discussion of the place of the battleship in national defense evoked much and energetic discussion. Professor Rossell's remarks serve as basis for his article on the subject in this issue of The Review.

A subject in many ways related to Commander Rossell's address in October was presented at the meeting of November 28 by Professor Frederick K. Morris of the Department of Geology, who discussed conditions in the Far East, speaking both as a geologist experienced in those regions, and as a recent visitor to them. The dangers of emotionalism in thought about Asia were stressed by Professor Morris, who analyzed the present Sino-Japanese War dispassionately in terms of the economic, strategic, and (*Continued on page 140*)

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NAVAL ARMAMENTS

(*Continued from page 122*)

radially at the velocity of sound in water and with little loss of energy. At considerable distances from the center of explosion, the pressure wave is capable of breaking through the shell of a large ship. Hence a ship with a single skin along its sides is especially vulnerable to attack by the pressure wave. A homely illustration of the propagation of a pressure wave is the juvenile practical joke of striking two stones together under water to the discomfort of a companion in the act of swimming beneath the surface.

Entirely apart from the pressure wave, an underwater explosion results in the formation of a globe of gas at great temperature and high pressure. This globe in expanding tends to vent its energy in directions of relatively low resistance. Thus if the explosion takes place near the surface of the sea, the energy of the gas globe will be expended principally in throwing into the air a large column of water. If the explosion takes place in contact with the side of a surface ship, the gas globe will vent itself both upward and inward. The percentage of energy passing into the ship with resulting damage will depend upon the resistance offered by the ship's structure and by the inert mass, such as coal, which is present near the skin of the ship. In passing into the ship the gas burns off fragments of the shell and hurls them inboard. These fragments may pass entirely through a vessel of the merchant type, and they may cause the explosion of the magazines of a war vessel having a weak defensive system against underwater attack (the *Pommern* at Jutland).

MEANS OF DEFENSE

So much for the means of attack available to aircraft. Now let us consider defensive measures, both passive and active.

The passive means of defense are essentially those used for protection of ships against torpedoes, mines, and long-range gunfire; namely, the fitting of armored decks above water and honeycombs of watertight bulkheads (partitions) along the sides below water. These defensive features are so heavy and require so much space that they can be carried in fully developed form only on very large war vessels.

In respect to passive defense against air attack, battleships and battle cruisers are very strong, cruisers are weak to fairly strong depending upon size, and destroyers and merchant ships are very weak. Airplane carriers are strong except for their extremely vulnerable flight decks and hangars.

One of the most important of the active means of defense against air attack is the large-caliber antiaircraft gun (four or five inch) with mechanical control and with accurate range- and direction-finding instruments. This gun has a rapid rate of fire — one round about every four seconds — and its projectiles upon bursting deliver a strong blast which would be extremely uncomfortable to aviators and highly dangerous to planes.

Against airplanes which venture too close to their targets, machine guns, operated as one squirts a hose, offer a valuable active means of defense. Some of these guns fire explosive projectiles (*Concluded on page 138*)

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NAVAL ARMAMENTS

(*Concluded from page 136*)

more than an inch in diameter. Of importance also as active means of defense are the speed and maneuverability of surface ships. Destroyers and cruisers are inherently strong in these respects, while merchant ships in general are very weak.

And a final active means of defense is the airplane itself, particularly the pursuit plane. In this type of defense all surface craft except airplane carriers are weak. In a well-rounded fleet the deficiency, as far as warships are concerned, will be offset by carriers.

Taking account of all defensive measures, active as well as passive, we may conclude that warships on the whole are strong in defense against air attack and that merchant vessels are extremely weak.

HYPOTHETICAL WAR

Now let us assume a hypothetical war in which a strong naval power, *A*, is under the necessity of controlling the waters bounding her shores in order to safeguard the transport of troops across these waters and also to protect commercial shipping using her ports. Let us assume that the opponent, *B*, is weak in sea strength but is much superior in air power. The two countries are removed from each other, let us say, by only a few hundred miles of sea. The question is: Could *A* control the waters adjacent to its shores in the face of *B's* superiority in the air?

One course of action for *B* to follow would be to bombard from the air important cities within the boundaries of its enemy. This procedure would lead to substantial wastage of *B's* air force and would have no effect on *A's* control of the sea. Another policy which *B* might follow would be to attempt to destroy *A's* navy by repeated air attacks upon it. This policy doubtless would be followed to some extent, but again it would lead to great attrition in *B's* air strength and could hardly break down *A's* control of the sea even in a prolonged war.

On the other hand, *B* might decide merely to harass *A's* navy by occasional air raids in order to keep a large part of *A's* air strength in attendance upon the fleet. *B* could then use the greater part of its air force in attacks upon *A's* commerce and troop transports. Such a policy probably would force *A* to adopt the convoy system, using as escorts aircraft and light surface vessels armed with powerful antiaircraft batteries. Under these circumstances each air force might be expected to suffer losses roughly proportional to the air strength of its adversary. *A*, being on the defensive, doubtless would have a lower constant of proportionality than *B*. Nevertheless, if the ratio of *A's* air strength to that of *B* were initially very low, the air preponderance of *B* over *A* would become progressively greater, so that *A* might find itself shortly in a critical position in respect to the protection of its commerce and troop transports.

Of course, the foregoing speculations may prove to be very far from the truth in the unfortunate event of a war such as that imagined. The uncertainties are so great, however, that a strong sea power which might possibly find itself in the position of country *A* of our example would be ill advised in times of peace to neglect its air force and its antiaircraft defenses.

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The Institute publishes a variety of bulletins, as well as a catalogue of general information essential to the entering student. The Technology Review Bureau will be glad to send, gratis and post free upon request, one or more copies of any publication listed below, or to forward any special inquiry to the proper authority.

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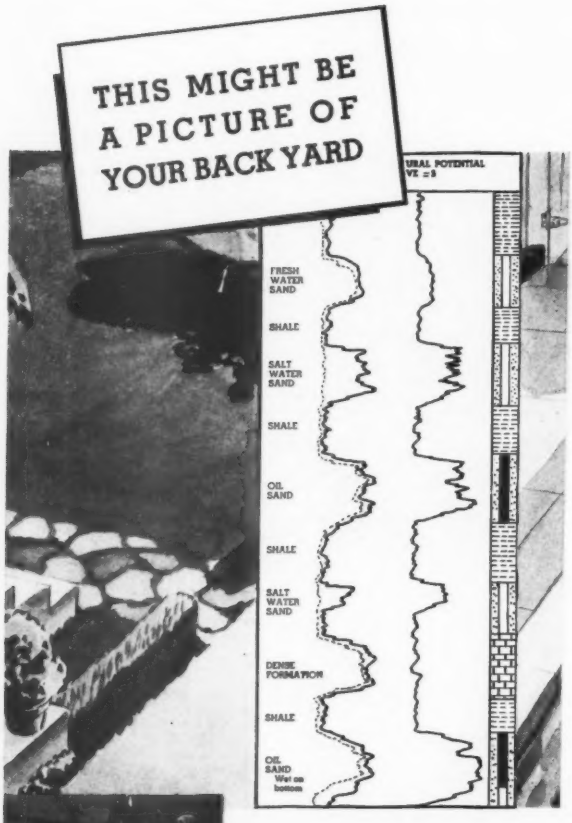

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THE INSTITUTE GAZETTE

(Continued from page 134)

sociological factors involved in it. The situation of the Japanese armies, he concluded, is such that they cannot be expected to hold out another year, if one judges by Occidental standards; yet since the Oriental standards must prevail, any implied prediction must be seriously discounted. Extensive discussion followed Professor Morris' talk.

Reports on last spring's Alumni Day ceremonies by Professor John E. Burchard, '23, produced discussion of plans for this year, of which A. Warren Norton, '21, is protagonist. General approval of the 1938 program was voiced during the debate, and it was felt that but slight modifications of it should be made for 1939. These would mainly affect the length of meetings.

The December meeting it was decided to omit in view of the fact that the last Monday of this month follows Christmas. At the first meeting of the new year, to be held on January 30, the question of the Alumni Fund will be principal on the agenda, with David McCord, Executive Secretary of the Harvard Alumni Fund Council, as guest speaker.

The President's Report, Part II

LAST month we presented, for those who have not received the full report, a summary of part of President Compton's last annual report to the Corporation, in which he discussed the future of architectural education. In the following summary Dr. Compton examines the curriculum, discusses desiderata, and suggests certain changes for the future.

Educational Problems

Every procedure and every curriculum should continually be subjected to search for improvement. In this sense the number of educational problems is equal to the number of educational activities, possible as well as actual. Many of our basic operations have been the subject of intensive study and reorganization during the past decade. I will now mention only three problems which, in my judgment, particularly merit attention.

A sound basis of procedure in education, as well as in engineering, business, or any other affairs of life, is to try intelligently conceived experiments and then to develop vigorously in those directions in which the experiments have been successful. In our educational program at M.I.T., two experiments have proved decidedly successful, the coöperative courses and the honors courses. Should not the scope of their operations therefore be extended?

Coöperative Courses

As coöperative courses I include not only our courses thus designated in Electrical and Mechanical Engineering but also our Chemical Engineering Practice Schools, which have many similar features, though differing in details. Such courses are decidedly successful from our educational point of view, *(Continued on page 142)*

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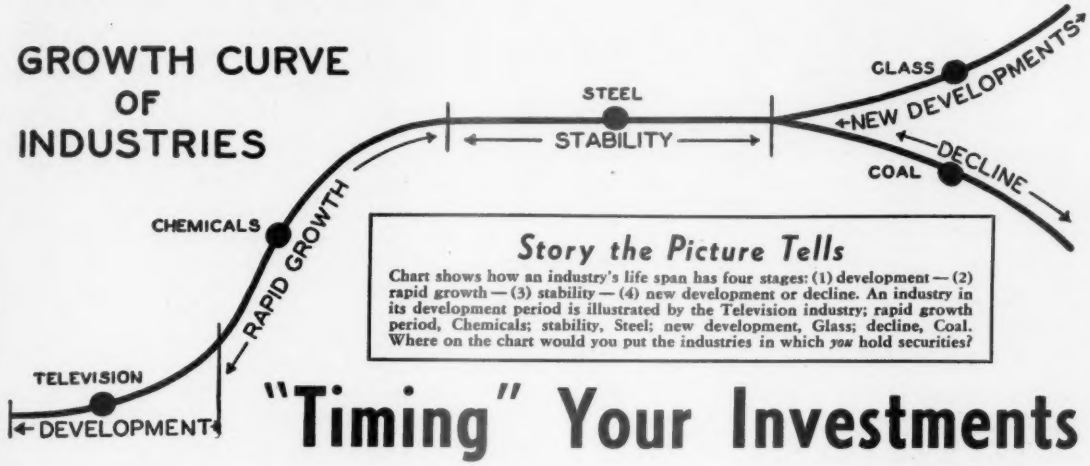

Story the Picture Tells

Chart shows how an industry's life span has four stages: (1) development — (2) rapid growth — (3) stability — (4) new development or decline. An industry in its development period is illustrated by the Television industry; rapid growth period, Chemicals; stability, Steel; new development, Glass; decline, Coal. Where on the chart would you put the industries in which *you* hold securities?

"Timing" Your Investments

Correct timing in investing means more than buying stocks when they are low and selling them when they are high. Successful investment timing must consider a third phase: "life-time." This is pictured in the chart above.

Just as business as a whole has its periods of prosperity, stability and decline, so too the individual industry must pass through the stages of childhood, maturity and old age.

Your Vital Question

The important question for an investor to ask is: How old is the industry and in what period of its own industrial life is it? These divisions of an industry's life span are roughly four: (1) development; (2) rapid growth; (3) stability; and (4) new development or decline.

Auto — a Good Example

As an example of what a new industry faces in the development period, consider the automobile. For twenty years, from 1890 to 1910, this industry went through innumerable hardships and growing pains. It lacked popular acceptance, output was low, costs high, and mortalities among all companies heavy.

Boom Period

Then in 1910 the industry began to emerge from its formative period into a new cycle in which mass production supplanted hand methods. Then followed a period of great expansion beginning in 1916 and continuing until 1929. Today the automobile industry is in the period of stabilization.

Too New?

Television, on the other hand, can be classed as still in the experimental stage. Chemicals, to take another illustration, are on the steepest part of their life line. Coal appears to be on the down-grade while glass has found a new lease on life.

Big Profit Time

From the investment viewpoint your capital should be distributed mainly in those industries which are in the period of middle growth. They are beyond the promotional problems and yet are still not approaching the saturation dangers. It is the ideal stage in the life of an industry.

Check Your List

It is the profit zone for the corporation and its stockholders. It is the correct location for the bulk of your holdings. On the above chart decide where you would place the various industries in which you hold securities. When thus examined your investment portfolio should meet two tests.

Make Two Tests

First: Is your capital diversified over a reasonably broad range? Second: Are you well represented among industries which are in the period of greatest growth? Have you kept the majority of your funds out of raw industries on the one hand, and out of fading industries on the other?

A Three-Fold Plan

On Babson's Supervised List there are about 250 securities distributed over approximately 30 different industries. We recommend the purchase of those which we believe are timed for the period of rapid growth. There are others the sales of which we are advising at the present time.

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Under the Babson plan of Automatic Supervision, clients are not only told when we believe they should sell individual stocks and bonds but also when they should buy into an industry, and when they should get out of an industry.

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THE INSTITUTE GAZETTE

(Continued from page 140)

and they are reported to be attractive to the coöperating companies. It would therefore seem to be a logical next step to attempt the establishment of similar cooperative arrangements in such fields as industrial chemistry, metallurgy, automotive and aeronautical engineering, and any other industrial fields in which employment is large enough to make possible the detailing of sizable groups of students to work in industrial plants under instructional supervision. I do not advocate for us that type of coöperative education, followed in some institutions, which consists chiefly of alternating periods of a few weeks each of work and study — a plan which is useful in my judgment only when it is the alternative to no education at all or, perhaps, when dealing with students on the trade-school rather than the technological-school level.

Moves in this desirable direction of closer educational coöperation between the Institute and industry have recently been made by our Department of Naval Architecture and Marine Engineering in arranging, with the aid of that Department's Visiting Committee, for a year of experience at sea by students before entering their senior year. The School of Architecture has made some analogous arrangements with near-by city and regional planning agencies and is seeking to provide useful practical experience to its students through summer employment on building jobs.

Honors Courses

Our honors courses were first tried out in Electrical Engineering. After evaluation of results, the Faculty then extended to all other Departments the opportunity to establish such courses. Thus far only one other Department, Chemical Engineering, has tried the plan, although Chemistry also has put some of its provisions into effect without adopting the name of honors course.

The chief features of these courses are: (1) careful selection of students admitted; (2) privilege of unusual freedom from supervision, combined with unusual opportunities for consultation with instructors; (3) final comprehensive examinations. In general the plan works well with the best students and not with others; it is more expensive to operate because of the greater individuality of the students' work. Its great assets are its development of initiative and responsibility and its opportunity for progress unrestricted by the slower gait of fellow students.

During the past year the Faculty has begun a reëxamination of the possibility of extending the honors plan

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into other Departments, and this study will be continued in the present year. The following facts have emerged from the study thus far:

(1) Many of the features of honors plans, as in operation in other colleges, are already incorporated in our educational program for all students.

(2) We already have wide latitude in avoiding regimentation or the repression of the most brilliant students. For example, one student recently was awarded both a bachelor's and a doctor's degree within less than four years after matriculation as a freshman. Many undergraduates take postgraduate studies. Every undergraduate has at least one experience in independent research, his thesis. Our upper-year classes generally have a ratio of number of students to instructors which compares favorably with the tutorial and similar groups in institutions which have adopted such plans. The large proportion of laboratory courses in our curriculum gives unusual opportunity for personal contact between students and instructors.

Despite what we already have in these lines, many of us believe that we can advantageously go still further. For example, I believe that there is a very sound educational basis for comprehensive examinations in the senior and, perhaps less extensively, in the junior years, and preferably with some oral as well as written parts.

FELLOWSHIP FUND

For selected graduate students who have previously been earning their Graduate School expenses through half-time employment as teaching fellows or assistants, there would be great benefit from an advanced fellowship fund to be available in the last year of their work for the doctor's degree. The large part-time-assistant, part-time-graduate-student group includes many of our ablest and most deserving advanced students. Their teaching or assistant's duties are valuable to them as training and experience, as well as enabling them to pursue advanced study. But this makes a long, hard road to the doctorate, and sacrifices some of the thrill and the efficiency of full-time devotion to study and research in the last year of graduate work.

It is certain that large benefits would come from a group of special graduate fellowships, with stipends of, say, $1,000 or $1,200, awarded annually to the most promising of the part-time teaching fellows or assistants who have come to the stage at which one year of full-time effort should achieve the doctor's degree. The benefits would include better opportunity for, and performance by, these students; relief from part of the social pressures — for example, the long postponement of marriage — so frequently imposed by the necessity of a very prolonged educational program; greater attractiveness to our teaching fellowships and assistantships, which would enable us to draw a still better selection of these useful young colleagues. To put the plan into effect on this scale would require about $25,000 annually for fellowships. I know of no other way in which additional funds could be devoted more advantageously to the simultaneous objectives of aiding promising young men and aiding the Institute to do a better educational job.

FUNDS FOR RESEARCH

Having devoted strenuous efforts in the past year to bringing into healthy balance the recreational opportunities for our students, even though these efforts only partially attained their objectives, and having our physical plant now in relatively adequate condition, I would suggest that our thoughts for future improvement follow other channels for the time being. In addition to the advanced fellowships just mentioned, and to such funds as may aid in promoting the best possibilities of the coöperative and honors plans of undergraduate study, our greatest opportunity for increasing significantly our contributions to human welfare is undoubtedly dependent upon increased (*Continued on page 144*)

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THE INSTITUTE GAZETTE

(Continued from page 143)

funds for research. I have said this same thing on previous occasions. I do not need to defend this viewpoint by answering the criticism that it is ideas and genius primarily, and money only secondarily, which bring values in research. I do not need to argue this, for every one of you has, through Visiting Committee duties, seen part of the vision of what the Institute could accomplish for the benefit of humanity with the ideas and genius already waiting only for the resources to make this vision a reality. We are doing a good deal in such lines now, but we are only scratching the surface of what we might be doing. I probably feel more keenly about this than you do simply because I have had better opportunity to examine the imminent possibilities in this line all through the Institute.

Let me give just one illustration of the many situations with which Dean Bush and I have had to struggle literally every day. Two years ago one of our professors came to us with a very interesting and entirely original suggestion for reducing dangers from floods. He had found that some soils may, from organic materials such as come from decaying vegetation, come into such a colloidal condition as to be almost impervious to water. In such condition, rain water will not soak into the soil but will rapidly run off its surface in the manner to produce floods. But he discovered that exceedingly small amounts of cheap chemicals could change the colloidal condition of this soil so that it would let water soak through it freely, which is exactly what is desired to reduce flood hazard and store water in the ground. Being himself swamped with a rapidly increased teaching program, he asked for assistance to secure a large selection of undisturbed samples of soil from some agricultural watershed, such as the Ohio River, and to perform the necessary laboratory tests on these samples. I think you will agree that this is an interesting and novel suggestion in a very important field of human welfare, and the preliminary tests and calculations had shown that the suggestion was not a wild one. Efforts to secure funds to make these tests have proved unsuccessful.

You may well say to me that surely it should be possible to secure funds for so worthy an enterprise, to which I heartily agree. But the difficulty lies in the fact that this is but one of a hundred opportunities of equal

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average importance. The result is that we spend most of our efforts in trying to find ways and means for prosecuting these investigations; we succeed in a minority of cases, and the rest drag on to haunt us with an ever-increasing memory of lost and vanishing opportunities through enforced negligence.

I wish there were time to let you see some of these situations in detail. We are proud and enthusiastic over those cases in which ways and means have been found for carrying on important projects. But I think that you will understand why I have put a great research fund at the forefront of our major needs, if you expect us to take good advantage of our ever new opportunities to advance human welfare.

ENDOWED PROFESSORSHIPS

A letter from one of our group has called attention to a very surprising peculiarity of the Institute: It has not one single endowed professorship. Harvard has 103, Yale 79, Oxford 62, Columbia 58, Cambridge 49, Princeton 36, and Chicago 21, according to a recent compilation by President Hutchins of Chicago. In endowment campaigns of other universities, endowment of professorships has often been found to be the most appealing of all objectives. We have, I think, only two professorships named as memorials, and neither of these is endowed. We had made a start toward endowing a professorship to honor our late great colleague, Elihu Thomson, but this was held in abeyance during the depression, pending more favorable times. Some of you have expressed the thought that a professorship named for the late President Maclaurin and contributed by Alumni who were students during his administration would be the most appropriate memorial to this great builder of the new Institute of Technology.

The least that I can do is to call your attention to this great lack and great opportunity. The least that you can do is to call it to the attention of others. No more permanently useful gift and memorial is possible in the entire field of education than a professorship whose influence will be spread and multiplied.

Gentlemen, I appreciate your interest in this inadequate review of status and needs of Technology. The Institute needs your continued active interest, and I greatly need your help and counsel. The social value of the Institute's objectives justifies all our combined efforts to carry them forward.

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THE TREND OF AFFAIRS

(*Concluded from page 117*)

across), dramatic in execution, and meticulously studied as to exhibition technique but it also posed some very interesting questions for the future. These are of more importance to Americans than the mere fact that, due to Munich, the French government has lost interest in such things as museums of science.

Such a project immediately raises some provocative questions. How well were the disciplines organized? Is it desirable to try to purvey science to the public this way? Is it possible? Is the mind which needs to be overwhelmed by a high-voltage display in order to want to visit the disciplines, the kind of mind which can understand what is to follow? Should not there have been much more provision for educational extension through a good lending library and other tried mechanisms?

More immediately traceable to the architect are three important ideas. Nelson is unquestionably a modernist, but the simplest examination of his project will show that he has left behind him the cold-blooded rationalism which has produced what we are familiar with in modern architecture and has attempted to superinduce on that a humanism, the lack of which has bothered many of us. Equally important is his effort to create a fuller flexibility. We live in a fast-moving world in which only the Japanese have succeeded in producing flexibility in any building. Rapid obsolescence indicates that more attention must be paid to this problem. Most stimulating of all perhaps is to see an architectural project which suggests daring but possible engineering.

Here one more point may be raised:

Affairs in Europe have unquestionably resulted, and presumably will continue to result, in sending to our shores more and more of the stimulating minds of the Continent. Europe has long had to conserve materials; it is entirely natural that these men should come to us with a background which uses daring engineering almost from force of economics. But has not the time perhaps come when we can venture some of these things ourselves? We have the technical knowledge, and our engineers — our aeronautical engineers, at any rate — have the imagination. Cannot American architects and American engineers, deriving stimulus from the discoveries of aeronautical engineering, begin to contrive buildings which pioneer instead of follow? We have reached a ridiculous time in world affairs if, in the very moment when every individualist on the globe looks to America for protection of the individual, Americans must still look across the water for every individualistic suggestion in the arts.

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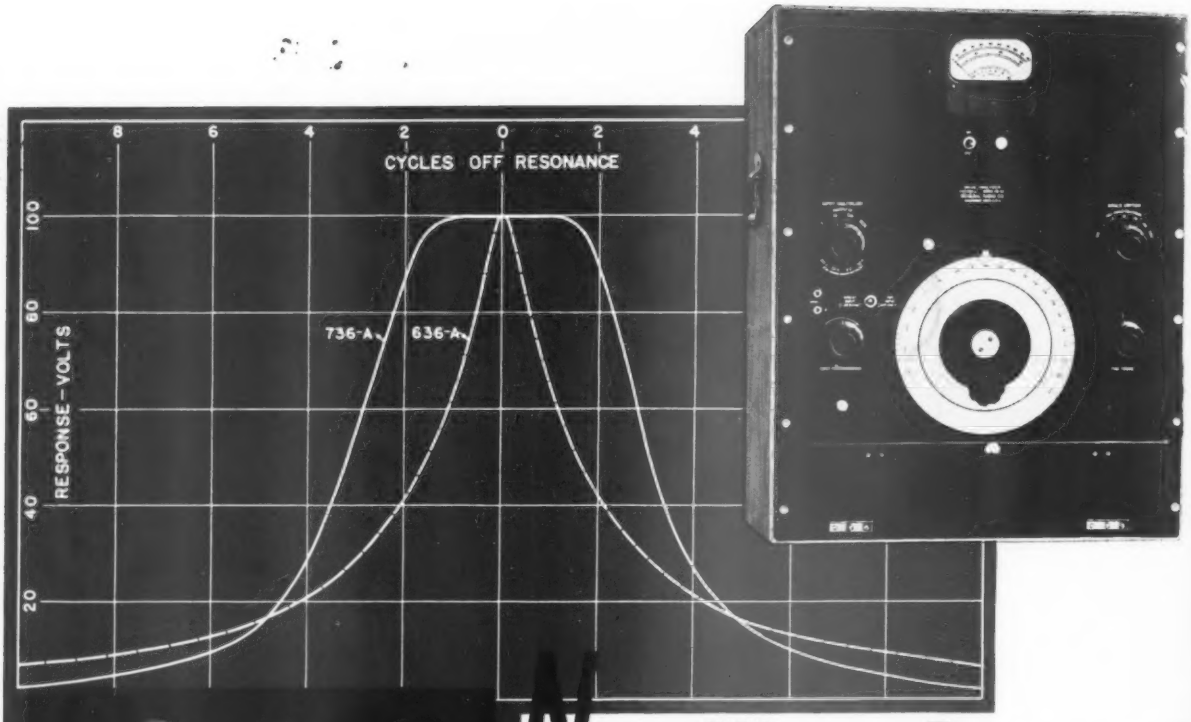

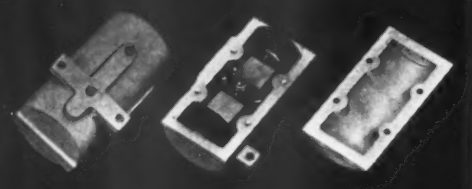

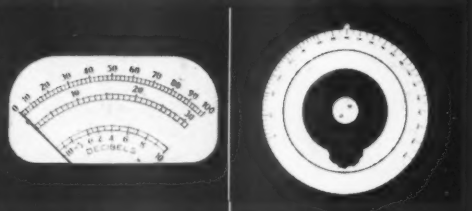

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